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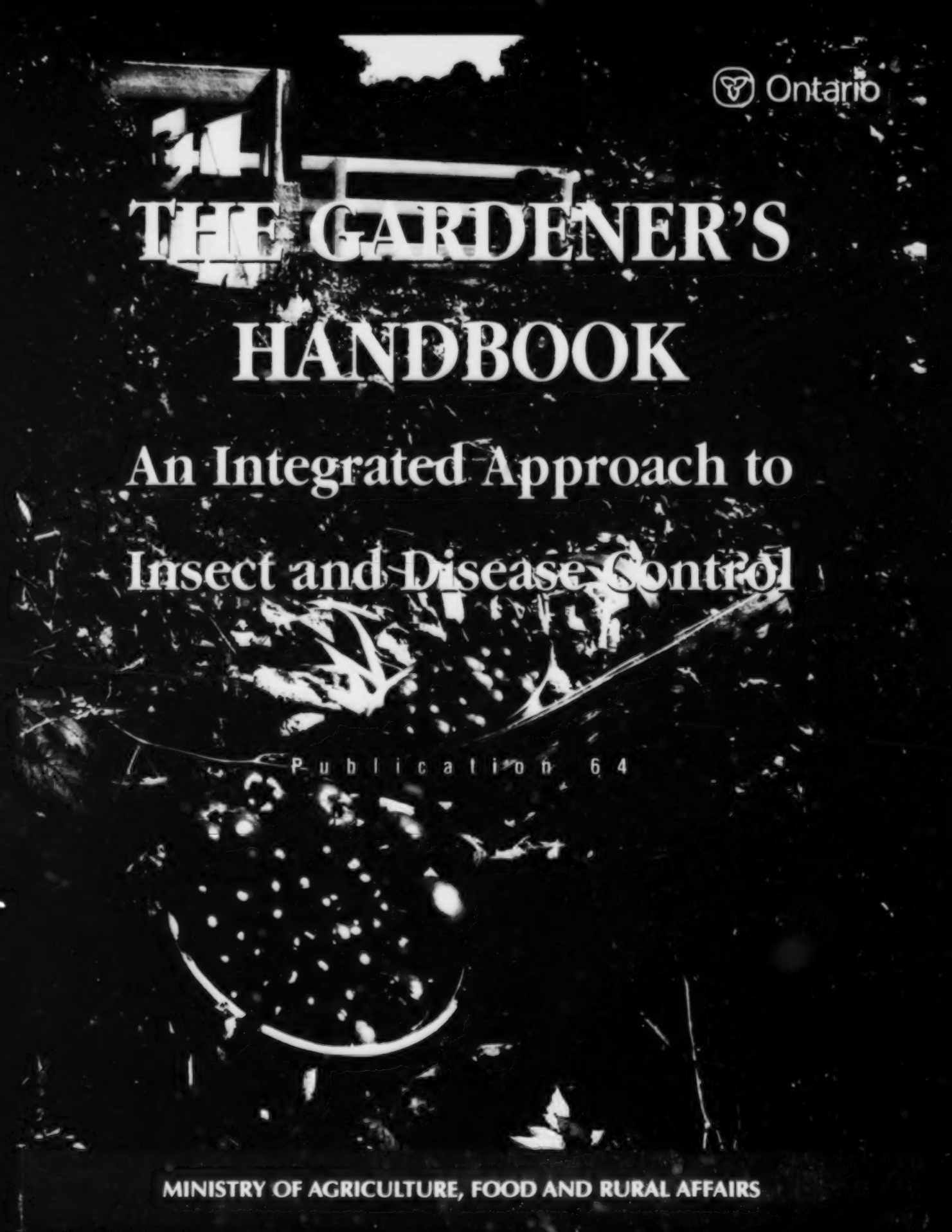

Ontario

THE GARDENER'S HANDBOOK

An Integrated Approach to Insect and Disease Control

Publication 64

MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS

Each year the Ontario Crop Protection Committee reviews the pesticides listed in this publication. To the best knowledge of this committee, all of these pesticides were:

- federally registered
- reviewed by the Ontario Pesticides Advisory Committee and
- classified by the Ministry of the Environment as of November, 1997.

Discard old editions of this publication.

The information in this publication is general information only. All pesticides must be used in accordance with the product label and *Regulation 914* of the Ontario *Pesticides Act*.

Pay close attention to all instructions and warnings on the pesticide label.

By printing this publication, the Ministry of Agriculture, Food and Rural Affairs does not offer any warranty or guarantee, nor does it assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

Policy Statement

In this publication, most recommendations list several pesticides that can be used for each pest discussed. Pesticides have been listed alphabetically by common chemical name; not by efficacy or safety.

A number of brand names of pesticides are given in the back of the calendar as a convenience to the home gardener and are neither an endorsement of the product nor a suggestion that similar products are not effective.

Weather and other factors influence the effectiveness of pesticides and the likelihood of plant injury by control chemicals. Consult the package label and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, and so on. Wettable or soluble powders (WP, SP,WDG or DG are less likely to cause plant injury than liquid concentrates (EC, SC, and F).

Health Canada has established maximum residue limits (MRL's) for pesticides. However, growers should be aware that processors or retailers may demand more restrictive limits. Growers should seek advice of their intended market as to which restrictions or limitations apply.

Federal Registration and Provincial Classification

The Ministry of the Environment administers Ontario's *Pesticides Act* and *Regulation 914*.

All pesticides sold and used in Ontario must be:

- registered under the federal *Pest Control Products Act*, and
- classified under the provincial *Pesticides Act* by being placed in one of six schedules of the Ontario regulation.

Federal Registration

There are three federal registration categories.

1. Full Registration

   The federal government agrees the data package was acceptable at the time of registration.

2. Temporary Registration

   Additional scientific or technical information is required to obtain full registration. Temporary registrations expire on the 31st of December each year and the products must be re-registered yearly.

3. Temporary Registration (Restricted Class)

   While the pesticide is urgently needed, studies on the safety of the product are incomplete. Such registrations expire on the 31st of December each year and the products must be re-registered yearly.

Provincial Classification

There are six classification schedules in *Regulation 914*. Pesticide products are classified on the basis of their toxicity, environmental or health hazard, persistence of the active ingredient or its metabolites, concentration, and usage. This system is needed to regulate the distribution, availability and use of pesticide products in Ontario.

For up-to-date information on the regulatory status of these or other pesticides contact the:

Pesticides Section,
Standards Development Branch,
Ministry of the Environment, Toronto.
Telephone (416) 327-5519

Cette publication est aussi disponible en français.

The recommendations in this publication have been prepared in consultation with the: Ontario Crop Protection Committee, Ontario Horticulture Crop Research & Services Committee, Ontario Soil Management Research Committee, and staff of the Ontario Ministry of Agriculture, Food and Rural Affairs, and the Ontario Agricultural College, University of Guelph.

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AN INTEGRATED APPROACH TO SUCCESSFUL GARDENING

The Gardener's Handbook - An Integrated Approach to Insect and Disease Control is an easy reference guide to the most common pest problems you are likely to encounter in the home garden. It provides a discussion of damage and disease processes, descriptions of plant pests, details of control options, and broader information on maintaining the health of your garden. Much of the general information, as well as a detailed look at how damage is done, is found at the front of the manual, and we recommend that you read these sections first.

The remainder of the publication is divided into four commodity sections: vegetables, fruit, ornamental plants (trees, shrubs, and flowers) and lawns. In the vegetable and fruit sections, host plants are listed alphabetically, followed by detailed information about corresponding pests and diseases. In the lawn and ornamental sections, it is the disease and pest problems that are listed alphabetically.

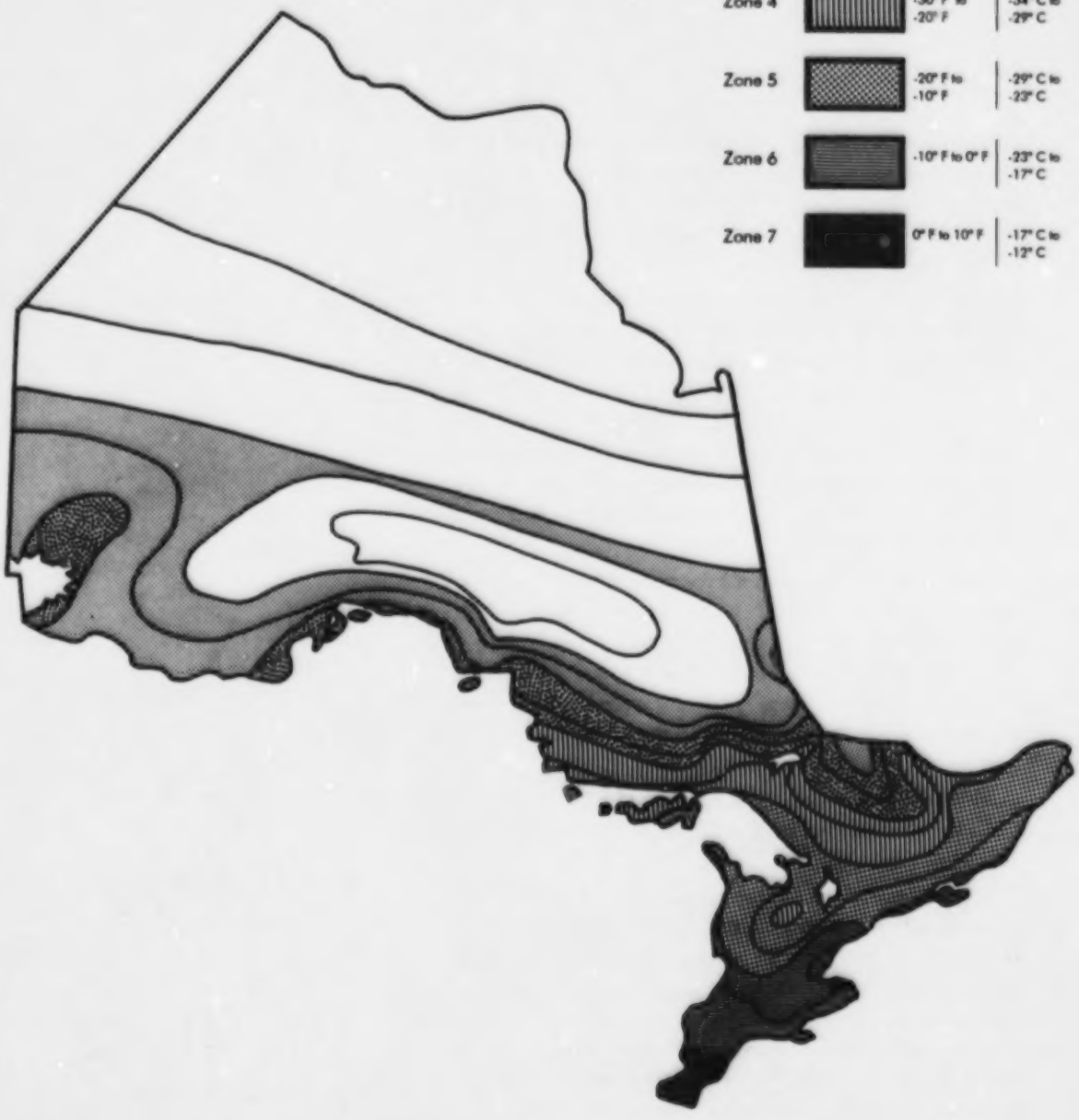
Throughout this manual, emphasis is placed on non-chemical means of pest control. These will at times include mention of horticultural practices, and some guidelines are provided here. For more detailed information, however, you are advised to consult any one of the many excellent garden reference books available today. Unproven control methods based on folklore or hearsay are not included in this manual.

Cultural control strategies are not guaranteed to be fully effective. However, they are often sufficient to keep pests to an acceptable level.

The mini-environment of the garden is important and should be protected. For this reason, the use of pesticides is recommended only when other measures prove inadequate. It is also up to you to decide if chemical controls are really necessary. A few aphids on a flowering crab or a gall from the maple gall mite on a silver maple will not cause serious harm, though they may disfigure the plant. Wherever possible, an integrated approach that combines cultural, chemical and other control practices is recommended.

Ontario Climate Zone Map

The temperatures given indicate the lowest range that a plant will tolerate. Remember that this is a guide only, and the conditions that a plant will tolerate depend on many factors, such as the amount of shelter given to the plant and its position in your garden.



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HOW DAMAGE IS DONE

Damage to your garden comes from one of four sources: insects, diseases, mammals and abiotic injury. These four categories are introduced in the following pages. Details of specific pest problems are provided in each commodity section.

INSECTS CAUSING PLANT INJURY

Many kinds of insects cause injury to ornamental plants and it is not possible to discuss them all in this publication. Only commonly observed insect problems are mentioned.

Insect pests can be divided into five broad categories according to their feeding habits and the damage that this causes:

Defoliators

Defoliating insects eat leaves and stems. They may feed singly or in dense colonies and their feeding habits vary. Some eat entire leaves while others eat only interveinal tissue; some skeletonize a leaf while others mine between its surfaces. Either way, photosynthesis is affected, and the plant is deprived of food.

While some defoliators can be seen, many others hide within a web, folded leaf or portable shelter.

- **Caterpillars** are moth and butterfly larvae that feed in colonies or individually. They have three pairs of true legs on the abdomen, close to the head; about 5 pairs of fleshy "pro-legs" are located further back along the abdomen. This group also includes loopers or inchworms that have two or three pairs of pro-legs.

- **Leaf Eating Beetles** feed on leaves both as

adults and as larvae. They can completely devour, skeletonize or mine the leaves.

- **Leafminer** larvae develop within leaf tissues. While they are often concealed, their characteristic tunnels are easy to identify. They can be straight, serpentine or irregular.

- **Sawflies** feed in colonies and quickly strip leaves from their host plants, usually in June and July. The adults have four wings and often resemble small, amber-coloured bees. The larvae of most look similar to caterpillars with three pairs of true legs on the abdomen, close to the head. They usually have seven or eight pairs of prolegs, however, located further back along the abdomen.

Sucking Insects

Sucking insects weaken plants by sucking the sap. Some also inject secretions that injure or kill plant cells. Because leaves are not chewed or torn, infested plants may suffer severe injury before symptoms appear. Signs of damage include mottling and fading leaf colour, curling and twisting leaves, wilting of foliage and tender shoots, and malformed flowers.

- **Aphids** are small, soft-bodied, pear-shaped insects of varying colour that cluster on new growth. They secrete a sweet sticky substance on which black sooty mould may grow.

- **Leafhoppers** are small, wedge-shaped active insects, usually green, yellow or striped, that run, hop or fly when disturbed. They feed on the undersides of leaves causing stippling or bleaching; small, white dots appear on the upper surface of leaves. The cast skins of the nymphs often remain attached to the lower surface of leaves.

- **Mites** are related to spiders and so are not true insects. Often called spider mites, these tiny pests produce webbing between needles or leaves that protects them from their natural enemies and from being dislodged. Mites reproduce rapidly during hot dry weather, producing several generations. They attack evergreens and herbaceous ornamentals causing speckling, bleaching or bronzing of the foliage. Species include European red mite, Spruce spider mite, two spotted spider mite and rust mite.

- **Thrips** are tiny, slender-bodied insects that affect the leaves and flowers of many perennials and annuals.

- **Plant Bugs** use their piercing, sucking mouth parts to remove plant sap. Both adults and nymphs cause damage. Symptoms include stippled leaves, deformed leaves and stunted shoots.

- **Scale Insects** are tiny and inactive most of their lives. They often blend with the host twig or leaf colour, making them hard to see. Scales can be divided into three groups:

Armoured scales vary from 2-3 mm in length or diameter and secrete a hard, waxy covering over their bodies. They may be circular, oblong or pear-shaped and commonly attack trees and shrubs.

Soft scales are either bare or enclosed in waxy or cottony secretions.

Mealybugs are soft-bodied insects usually covered with a powdery or cottony wax. Mealybugs produce honeydew.

Borers

Borers are beetle and moth larvae that tunnel into the buds, shoots, bark or wood of trees and shrubs. Some species attack healthy trees, but most attack trees and shrubs already under stress from another cause.

Infested plants are often damaged beyond repair before you are aware of the presence of borers, so prevention is critical. Signs of damage include dead branches or

areas of bark, and sap and sawdust-like borings on the bark or on the ground.

Gall Makers

Galls are abnormal growths produced by a plant in response to insect irritations. Causes include feeding, stinging or egg-laying. Galls generally benefit the pest by providing a protective shelter for the insect to complete its life cycle.

- **Midges** and **gall wasps** are the most common gall makers. Each species produces a characteristic gall, and oaks, silver maple, hickories, spruce and Douglas fir are their favourite hosts. They rarely kill the tree but can greatly affect its appearance.

Soil pests

Pests below the soil line can seriously damage plants before most gardeners are aware of their presence. It is often difficult to determine the extent of the pest problem or the effectiveness of treatment.

- **Japanese beetles** are regarded as a serious pest by Agriculture and Agri-Food Canada and currently are restricted to the Niagara, Hamilton-Wentworth and Haldimand-Norfolk regions of Ontario. The larvae feed on the roots of turf and many ornamental shrubs.

- **European chafers** cause serious damage to many lawns.

Larvae of **taxus weevils** and **strawberry weevils** can cause the death of many plants including yews, rhododendrons, and strawberries.

Use Table 1 on the next page as a first guide to identifying the pests in your garden.

TABLE 1. Location of Plant Damage, Symptoms and Possible Causes

Category	Symptom	Possible Causes
Chewed leaves and/or chewed flowers	Pieces of leaf or flower missing	Caterpillars (moth larvae, butterfly larvae)
	Entire leaves or flowers missing	Larvae or adult beetles, Sawfly larvae, Grasshoppers, Snails, Slugs
Discoloured leaves	Bleached leaves	Lace bugs
	Bronzed leaves	Plant bugs
	Silvered leaves	Spider mites
	Stippled leaves	Leafhoppers
	Streaked leaves	Aphids, Psylids, Thrips
Parts of plant are distorted	Mined leaves	Beetle larvae
	Skeletonized leaves	Caterpillars, Sawflies
	Curled/cupped leaves	Aphids
	Galls on leaves, stems, flowers, twigs	Thrips, Gall wasps
	Twisted growing points	Gall flies, Psylids, Eriophyid mites
Parts of plant die	Dying leaves, twigs, branches	Twig pruners
	Dying whole plant	Root feeding beetle larvae
	Holes and frass observed	Boring insects, Scales
	Wilting	Adelgids
	Dark fecal spots	Aphids, Soft scales, Leafhoppers, Mealy bugs, Psylids, Whiteflies
	Honeydew Sooty mould	Lacebugs, Whitefly, some plant bugs, Sawfly adults
	Silken mats	Leafrollers, Leaf tiers
	Spittle	Spittlebugs
	Tents	Tent caterpillars
	Webs	Webworms
Visible insect matter	Cast skins	Aphids, Cicadas, Clearwing moth larvae, Lacebugs, Leafhoppers
	Pitch mass	Larvae of certain kinds of moths and beetles
	Sap flow	Larvae of certain kinds of moths and beetles
	Pitch tubes	Bark beetles
	Cottony waxy material (Flocculence)	Adelgids, Aphids, Certain scales, Mealybugs, Psylids
	Slime	Slugs, Snails

Ontario Insect Development Calendar

To effectively control insects, it is important to understand the life cycle of the pest that is attacking the plant(s) in your garden. Cultural and chemical strategies are only effective when applied at the correct time and in the most effective way. It makes no sense to apply a chemical when the controllable stage is no longer present.

The following table outlines when various insects are active and when you should watch for their activity. Keep in mind that small numbers of beetles and caterpillars can be removed by hand, and that birds and other beneficial insects often reduce harmful insects to acceptable levels.

It is rarely necessary to spray large shade trees in your garden, as they can easily tolerate considerable insect feeding. If defoliation occurs within successive years, however, they will be weakened and controls may be necessary. When spraying large trees is required, a licensed pest control operator or tree maintenance service should do the work.

On young shade trees up to 7 m high, hose-end sprayers will provide sufficient coverage. Care must be taken not to inhale the spray drift or allow it to come in contact with the skin or eyes when performing this operation. Avoid contamination of swimming pools.

TABLE 2. Insect Development Calendar

Pest	April	May	June	July	August	Sept.	Host Plant
DEFOLIATORS:							
Birch Leaf Miners	Adult	Larva	Larva Adult	Larva Adult	Larva	OW Pupa	Birch
Cedar Leaf Miners	Larva	Larva Pupa	Adult Egg	Adult Egg	Larva	OW Larva	White Cedar
Dogwood Sawflies	OW Larva Pupa	Pupa	Adult Egg	Adult Egg Larva	Larva	OW Larva	All Dogwood
Eastern Tent Caterpillars	OW Egg Mass	Larva	Larva	Adult	Adult	OW Egg Mass	Hawthorn, Crabapple, Cherry, Plum
European Pine Shoot Moths	Larva Pupa	Pupa Adult	Adult	Adult Larva	Larva	OW Larva	Scot's, Red, Mugo Pine
Fall Webworms	Pupa	Pupa	Adult Egg	Larva	Larva Pupa	Larva Ow Pupa	Ash, Flowering Crab, Various Shade Trees
Forest Tent Caterpillars	OW Egg	Larva	Larva	Adult	Adult	OW Egg Mass	Hawthorn, Crabapple, Cherry, Plum
Gypsy Moths	OW Egg Mass	Larva	Larva Pupa	Pupa Adult	Adult	OW Egg Mass	Oak, Poplar, Birch, Maple & Conifers
Imported Willowleaf Beetles	Adult	Egg Larva Adult	Egg Larva Pupa Adult	Egg Larva Pupa Adult	Larva Pupa Adult	OW Adults	Willow, Polar
Japanese Beetles	Larva	Larva	Larva Pupa	Adult Egg	Egg Larva Adult	OW Larva	Rose, Linden, Cherry, Other Deciduous Plants
Oak, Birch, Apple Skeletonizers	OW Pupa	Adult Egg	Larva	Pupa	Adult Egg	Larva OW Pupa	Birch, Apple, Oaks

continued on next page

Pest	April	May	June	July	August	Sept.	Host Plant
Pear Sawflies	OW Larva Pupa	Pupa Adult	Larva	Pupa Adult	Adult Egg	OW Larva	Hawthorn, Mountain Ash, Serviceberry Cherry, Pears, Quince
Satin Moths	OW Larva	OW Larva	Pupa Adult	Adult Egg	Larva	OW Larva	Poplar, Willow, Oak, Aspen
Viburnum Leaf Beetles	OW Egg	Larva	Larva	Pupa Adult	Adult	OW Egg	European Highbush Cranberry, Arrowood Viburnum
White Marked Tussock Moths	OW Egg	OW Egg	Larva	Larva Pupa	Larva Pupa Adult	Adult OW Egg	Many Deciduous Trees
Yellow Headed Spruce Sawflies	Pupa	Adult Egg	Adult Egg	Larva	Larva	OW Prepupa	All Spruce
SUCKING INSECTS:							
Cottony Maple Scales	Immature Female	Adult	Adult Egg	Crawler	Nymph	OW Nymph	Maple, Black Locust, Oak, Sycamore
Crimson Erineum Mites	Adult Egg	Egg Larva Adult	Egg Larva Adult	Larva Adult	Adult	OW Adult	Silver, Red, Sugar Maple
Euonymus Scales	Mature Female	Egg	Crawler	Crawler	Nymph	OW Nymph	Euonymus, English Ivy, Lilac, Pachysandra
European Red Mites	OW Egg	Nymph Adult	Egg Nymph Adult	Egg Nymph Adult	Egg Nymph Adult	OW Egg	Crabapple, Mountain Ash
Fletcher Scales	Nymph	Adult	Adult Crawler	Crawler	Nymph	OW Nymph	White Cedar, Yew
Juniper Scales	OW Adult With Egg	Egg	Crawler	Crawler Adult	Adult	OW Adult With Egg	Juniper
Lecanium Scales	Nymph	Adult	Crawler	Crawler	Nymph	OW Nymph	Ash, Boxwood, Cedar, Honey Locust, Oak, Yew
Magnolia Scales	Nymph	Nymph	Nymph	Adult	Adult Crawler	OW Nymph	Saucer, Star Magnolia, Cucumber Tree
Oyster Scales	OW Egg	Crawler	Crawler	Nymph Adult	Adult	OW Egg	Lilac, Crabapple, Dogwood, Linden, Cotoneaster
Pearleaf Blister Mites	Adult	Egg Nymph Adult	Egg Nymph Adult	Nymph Adult	Adult	OW Adult	Serviceberry, Mountain Ash, Cotoneaster, Pear
Pine Needle Scales	OW Egg	OW Egg	Crawler Nymph	Crawler Nymph	Adult	OW Egg	Mugo, Scots, Austrian, Pine, Spruce
Pine Tortoise Scales	OW Nymph	Adult Egg	Adult Egg Crawler	Crawler	Nymph	OW Nymph	Scots, Austrian, Red Pine
Spruce Spider Mites	OW Egg	Egg Nymph	Egg Nymph Adult	Egg Nymph Adult	Nymph Adult	OW Egg	Spruce, Cedar, Juniper, Hemlock
Two-Spotted Mites	OW Adult	Egg Nymph Adult	Nymph Adult	Nymph Adult	Nymph Adult	OW Adult	Numerous Plants

continued on next page

Pest	April	May	June	July	August	Sept.	Host Plant
GALL FORMING:							
Cooley Spruce Gall Adelgids	Nymph	Nymph	Nymph	Nymph	Adult	OW Nymph	Blue Spruce, Douglas Fir
Eastern Spruce Gall Adelgids	Nymph	Nymph	Nymph	Nymph	Adult	OW Nymph	Norway & White Spruce, Englemann Spruce
Honeylocust Pod Gall Midges	OW Adult	Adult	Egg Larva Adult	Egg Larva Adult	Egg Larva Adult	OW Adult	Honeylocust
Maple-bladder Gall Mites	Adult	Egg Nymph Adult	Egg Nymph Adult	Adult	Adult	OW Adult	Silver Maple, Red Maple
Maple Spindle Gall Mites	Adult	Egg Nymph Adult	Egg Nymph Adult	Adult	Adult	OW Adult	Red Maple, Sugar Maple, Silver Maple
BORERS:							
Black Vine/Strawberry Root Weevils	Larva	Larva	Pupa Adult	Adult Egg Larva	Egg Adult Larva	OW Larva	Yew, White Cedar, Pine, Spruce, Hemlock, Euonymus, Rhododendron
Bronze Birch Borers	Larva	Larva Pupa	Pupa	Adult Egg	Adult Egg Larva	OW Larva	Birch
Eastern Pine Shoot Borers	Pupa	Adult	Egg Larva	Larva	Larva Pupa	OW Pupa	Pine
Lilac Borers	OW Larva	Pupa	Adult Egg	Adult Egg Larva	Egg Larva	OW Larva	Lilac, Ash
Locust Borers	Egg	Larva	Larva	Pupa	Adult	Egg Adult	Black Locust
Peach Tree Borers	OW Larva	Pupa	Adult Egg	Adult Egg Larva	Larva	OW Larva	Cherry, Purple Sandcherry, Peach, Other Prunus
Pine Root Collar Weevils	OW Adult	Adult Egg	Egg Larva Adult	Egg Larva Adult	Larva Adult	OW Adult	Scots, Austrian Pine
Poplar Willow Borers	Larva	Larva	Larva	Adult	Egg Adult	OW Larva Adult	Willow, Poplar, Birch
Zimmerman Pine Moths	Larva	Larva	Larva	Larva Pupa	Adult Egg	OW Larva	Pine

OW - overwintering

DISEASES CAUSING PLANT INJURY

Parasitic diseases are caused by fungi, bacteria, viruses and nematodes. These organisms attack plants, living at the expense of their hosts.

Fungal and Bacterial Damage

Fungal and bacterial diseases can be broadly categorised by the type of damage they cause.

Foliage diseases attack leaves. Leaves may turn yellow, drop off or become deformed due to vascular wilt or secondary factors such as air pollution or drought. Common diseases include Botrytis, powdery mildew, downy mildew, leaf spots, black spot, rusts, anthracnose and needlecast.

Crown and root rots often attack seedlings. The lower stem of the plant appears water soaked. Eventually, the plant rots off at the soil line. Soil fungi such Pythium and Phytopthora attack herbaceous and woody plants. Rhizoctonia and Fusarium cause brown to black lesions on lower stems and roots.

Canker diseases are fungal, and commonly attack plants weakened by drought, root disturbance or poor root environment. Cankers kill bark and underlying tissue in patches on branches and stems. The bark splits as it dries and is easily removed, exposing the wood below. Fruiting bodies from the fungus are often seen on the dead bark areas.

Vascular wilts occur when fungi or bacteria enter a plant's vascular system and reduce water movement to the leaves. Leaves often recover in the early stages during cool, moist periods. Eventually, however, leaves and branches wilt and die; the entire plant dies soon after. Serious wilt diseases include verticillium wilt and Dutch elm disease.

Fungi

Fungi are lower forms of plant life that must take their nourishment from a host to survive and reproduce. They appear as delicate strands (filamentous mycelium) that grow on or in plant tissue. Most reproduce by spores produced by the millions and spread by air currents, water, soil and insects. Under suitable environmental conditions, and if a suitable host is near, the spores will germinate and infect the plant. They enter through wound sites and natural plant openings or by forcing their way through the outer layer (epidermis) of plant tissue. Many fungi also produce resting spores that can withstand long periods of unsuitable conditions.

Fungi that attack foliage, flowers and stems are usually spread by air currents or splashing water. Fungi that attack plant roots, crowns or the sap stream of plants (wilts) survive indefinitely in the soil, until suitable germination conditions exist. The damage that they cause includes a breakdown of tissues (soft rot), cell death (necrosis or leaf spots) and the blockage of water-conducting tissues.

❖ **TREATMENT**

Cultural Control: Disease control in the garden is more than just a matter of applying chemicals. Moisture encourages the growth of fungus. Constant rainfall, heavy dew or excessive watering can all promote infection, and warm, humid weather alone can cause powdery mildew to develop rapidly. A simple preventive measure, therefore, is to keep your garden relatively dry. Wider spacing of plants and watering only in the morning to promote quick drying will help. Regular inspection of plants is also required, so that you can apply the necessary treatment before an infection spreads to other plants.

Chemical Control: Fungicides are used to control the spread of disease and to protect healthy plants from infection. They can not, however, cure those plants that are already damaged. For the best control, therefore, fungicides must be applied before infection occurs. Both upper and lower leaf surfaces must be covered, and repeated applications may be necessary at 5-10 day intervals to protect new growth and to replace fungicide which was diluted or removed by rain. Spray applications are more resistant to rain than are dust applications.

Some fungal diseases — such as black spot on roses — occur annually throughout Ontario. Yearly treatments are a necessity. Other diseases are a serious problem only in some years and in certain areas. In these cases, fungicides should be applied only when symptoms are noticed. Observa-

tions from the previous year are helpful in predicting the occurrence of a disease outbreak.

Fungicide Resistance

If you use a single systemic fungicide such as benomyl, thiophanate-methyl or triforine, the fungus may eventually become resistant, and the fungicide will lose its effectiveness. By alternating a systemic fungicide with one that is non-systemic such as captan, chlorothalonil, cycloheximide, dinocap, folpet, mancozeb or sulphur, the development of resistance can be avoided or delayed. These non-systemic fungicides have less specialized ways of preventing the growth of plant pathogens, and hence are less prone to cause resistance problems.

Bacteria

Bacteria are microscopic single-celled organisms that reproduce rapidly inside the plant under favourable conditions. Bacteria enter plants through wounds, pruning cuts and the pores of leaves. They can also be spread mechanically, though splashing water and rain is the most common delivery system. Once inside, they affect most parts of the plant.

Bacteria are often classified as wilts (as in geranium wilt) or blights (as in lilac blight). Wilt-causing bacteria tend to clog up the vascular tissue, inhibiting the flow of water and nutrients, while blights attack the young shoots and the outer layers of tissue first.

Symptoms of wilt disease appear primarily on the leaves, and include large V-shaped areas of dead tissue, yellowing, and a wilted appearance. Grey or black streaking may be apparent on leaves and stems. Under warm, humid conditions, plants collapse very quickly.

Blights may first appear as black spotting on leaves and stems. With many woody ornamentals, flower buds, young leaves, and shoots may turn completely black and die off. Infection occurs in early spring during extended periods of wet weather.

❖ **TREATMENT**

Cultural control: Remove and destroy of all infected plant material. Do not compost it. Avoid planting susceptible species in the same areas for at least one year, as the bacterium survives in dead or decomposing plant material.

Chemical control: None

Viruses

Viruses are only visible with electron microscopy. They reproduce only in the body of a living host. The most common viral diseases are classified by their symptoms: mosaics, yellows, stunts, mottles and streaks.

Viral diseases exhibit a variety of symptoms. The most common is the uneven yellowing of the leaf, which gives rise to a mosaic pattern of yellow and green. With some systemic viruses, the areas adjacent to the veins turn yellow. Still other viruses can cause ring spots, stunting, distortions of leaves and flowers, and premature death.

Many viruses are carried from infected to healthy plants by insects. Infection can also be spread by humans when handling plants or taking cuttings. Many viruses are carried over from season to season in tubers, corms and occasionally in seed.

❖ **TREATMENT**

Cultural control: As viruses are often spread by other pests, controlling aphids and leafhoppers is important in controlling viral spread. Care must also be taken when handling diseased plants. Affected plants should be promptly removed and destroyed to prevent the spread of disease.

Chemical control: None

Nematodes

Nematodes are microscopic worms that attack plant roots to obtain food. Leaves may also be attacked, though this is rare. The roots become stubby, with swollen knots or growths. (Do not confuse the nitrogen fixing nodules on leguminous plants with damage from nematode infestation.) Small lesions are also visible. As the disease progresses, root rot due to invasion by other organisms usually occurs. The plant gradually loses vigour, showing symptoms of drought, stress, nutrient deficiencies, and stunted growth. Nematodes thrive best in sandy soils.

❖ **TREATMENT**

Cultural Control: Soil infested with nematodes must be removed and replaced.

Chemical Control: None available to homeowners.

THE LARGER PESTS: Mice, Skunks, Rabbits and Other Mammals

Mice, Rats and Voles

In winter, mice live under the snow, travelling in and on the soil. They can become a problem when their normal food source is scarce. The damage they cause to bark, roots and lawns is not noticed until spring.

Voles can cause significant damage to young trees and perennials by girdling the lower stem and by feeding on the roots and crowns of perennials. Meadow voles usually feed on grass seeds and herbs but shift to bark in fall and winter.

For further information, see OMAFRA Factsheet 89-122, *Rodent and Deer Control in Orchards*.

❖ CONTROL

Place wire mesh tree guards around young trees, pushing them into the soil to a depth of 5 cm and surround them with stones to prevent digging. Maintain a grass free area around young trees and shrubs, and keep all grass mowed short to prevent the creating of a desirable environment for the animals to live and feed during the summer and fall.

Brush or spray repellents such as *Rabbit Repel* and *Skoot* on bark in late fall before a major snowfall. Temperatures should be above freezing. Apply when the bark is dry and rain is not expected, so that the repellent will dry thoroughly. One treatment properly applied gives protection until spring. Animals are repelled by the bitter taste but are not harmed. Place crushed stones around the base of plants to prevent mice from feeding below the treated bark or on the roots.

Severe infestations are rare in a normal urban garden, and are usually only a problem in rural areas. If this is the case, poisonous baits may be required. Use them only late in the fall if there is evidence of mice runways and tunnels. Most are anticoagulants, which means they reduce blood clotting and cause external or internal bleeding. Mice die painlessly after eating bait over a period of 3-10 days. A continuous supply of bait must be available. Place it in bait stations made of empty cans with a hole small enough so that only mice can enter, to keep bait out of reach of children, pets and birds and to keep bait dry. Anticoagulant rodenticides contain either warfarin, chlorophacinone, brodifacoum, dipacinone, fumarin, pindone or bromadiolone. Cholecalciferol (Vit D3) and ergocalciferol (Vit D2) are not anticoagulants. Baits are sold under various brand names. See list on page A-9.

Moles

Moles are small, plump, short-tailed burrowing animals with no visible ears and small, poorly-developed eyes. They spend most of their lives underground, burrowing constantly in search of worms, grubs and other soil insects. They can cause serious damage by lifting roots of perennials, bulbs, lawns and strawberry and raspberry patches. The tunnels they create let in air that dries out the roots.

❖ CONTROL

Set live traps to catch moles and release them elsewhere. Specially designed mole traps work on trip mechanisms, which the mole pushes as it tunnels through an existing burrow.

Treat the lawn with insecticide to control grubs (see page 126), causing moles to go elsewhere in search of food. This treatment does not kill earthworms so it will not be completely effective against moles searching for worms.

Rabbits

In winter when food is scarce, rabbits eat bark, twigs and buds of fruit trees and many ornamental trees and shrubs. When snow surface is frozen, they can reach a considerable height. If completely girdled, trees, shrubs or single branches die. Rabbits can also be a problem in the vegetable garden in the summer. Damage due to rabbits is usually a more serious problem in rural areas.

❖ CONTROL

Place tree guards (available at garden supply stores) or chicken wire around individual trees or shrubs. Guards must be tall enough to give protection under highest possible snow conditions. In the summer, vegetables can be covered with chicken wire netting, or a chicken wire fence can be placed

around vulnerable areas of the garden.

Brush or spray repellents such as *Rabbit Repel* and *Skoot* on bark of fruit trees, ornamental crabapples and other susceptible woody plants in late fall before a major snowfall. Temperatures must be above freezing. Apply when bark is dry and rain is not expected, so that the repellent can dry thoroughly. One treatment properly applied gives protection until spring. Rabbits, deer and rodents are repelled by the bitter taste but are not harmed.

Skunks

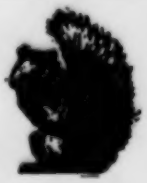
Skunks dig up lawns searching for grubs.

❖ CONTROL

Live traps can be used to trap the skunks for release in natural areas suited for wildlife.

Treat lawn with an insecticide to control grubs (see page 126). This will minimize the source of an attractive food supply.

Squirrels



Squirrels may strip bark from maples, eat buds off trees and rhododendrons, nibble on cherry, peach, pear and apple fruits, dig up bulbs and plant acorns and black walnuts where they are not wanted.

❖ CONTROL

Secure pieces of galvanized wire netting over newly planted bulbs using pegs or rocks.

Use live traps with peanut butter bait and release the animals in natural wildlife areas at least 20 km away, since squirrels have been known to return from lesser distances. Because other squirrels soon move in, however, trapping must be an ongoing program. Larger traps may be helpful in controlling rabbits and groundhogs.

Nail a 45-50 cm sleeve of aluminum, such as those used on roofs, around the tree trunk to prevent squirrel damage if there are no other trees from which the squirrels can jump. Strips should be at least 2 m tall. One end is nailed down at the corners and the other end is tucked under to hold it in place. Allow enough length for trunk expansion as tree grows and loosen nails periodically so the corners do not become embedded in the bark. Branches hanging lower than 2 m should also be pruned off. The same method can be used to prevent porcupines from climbing a tree to feed on bark.

Woodchucks or Groundhogs

Groundhogs or woodchucks can be found in a variety of habitats: fields, old pastures, fence rows, gardens and backyard hedges. They feed on grasses, clovers and succulent garden plants. They may also damage fruit trees or ornamental trees by gnawing the bark, and ruin root systems by digging burrows.

❖ CONTROL

Control must be a neighbourhood activity, to prevent animals entering from adjacent property.

Put up wire fencing around the garden to stop the groundhog from digging under. Bury the base to a depth of 15-20 cm and turn it outward in a trench, causing groundhogs and woodchucks to dig on an angle.

Live trapping can be a means of eliminating a few problem animals in the urban garden. Set the live trap (they can be rented from humane societies or local pounds) in an area frequented by the groundhog, baited with fresh string beans, sweet corn, peas, carrots or apples. Release the animals in a remote area away from gardens or commercial crops.

Groundhogs can also be controlled by use of gas cylinders. This should be done in early spring when the animals are in the burrows with their young; other animals such as snakes often take up residence in the burrows later in the year. The cylinders contain a mixture that produces carbon monoxide which asphyxiates the animal. Place the cartridge in the burrow entrance to a depth of 1 m and close all holes. Follow manufacturer's instructions carefully. Do not use under buildings.

Allowing a licensed exterminator to rid your garden of the pests is also a good alternative.

ABIOTIC INJURY

Abiotic diseases are those not caused by a living organism or virus, but by soil and weather conditions, or man-made physical and chemical disturbances. Leaf and root systems are usually affected and of the two, root problems are the most serious. Unless root conditions are improved, the plant may die.

The plant's response to abiotic injury depends upon the severity of the problem and the plant species itself. Oak, maple, ash and spruce, for example, are very sensitive to soil compaction, drought, root damage or sudden changes in weather conditions. Abiotic injury can also weaken the plant and predispose it to attack by insect pests and diseases.

To control abiotic diseases, improve overall growing conditions, avoid damaging factors and, whenever possible, select plants that are resistant to abiotic damage.

Air Pollution

Air pollution — particularly ozone, nitrogen oxides and sulphur dioxide — damages some plants more than others and is more severe in some areas of Ontario than in others. Ozone and nitrogen oxides are found in smog. Sulphur dioxide is formed primarily during the combustion of coal and oil.

The type of damage seen varies with pollution levels, as well as with the sensitivity of the plant.

Symptoms include leaf stippling or chlorosis and premature ageing of the leaves.

Autumn Shed of Conifers

This natural phenomenon is not a disease. All conifers undergo annual needle shed to varying degrees. Beginning in early autumn, needles toward the inside of the tree (closest to the trunk) turn yellow or brown and fall. Cedars and many junipers have scale-like needles covering tiny branchlets. These trees also shed the oldest branchlets in the fall.

Trees of low vigour, or under stress from factors such as drought, transplant shock, poor drainage or soil compaction may lose more than one year's quota of foliage. In such cases, identifying the problem and alleviating the stress will minimize autumn shed.

Compacted Soil

Pavement or compacted soil around trees prevents air and water from penetrating the soil. Heavy equipment working on a landscape site or considerable foot traffic can also result in soil compaction, especially in clay soils, resulting in the slow decline of both young and old trees.

Dieback

Dieback affects shade trees, and is found throughout Ontario. The gradual loss of vigour and dying back of branches are classic symptoms. The presence of short internodes, small, discoloured leaves and premature autumn colour may also occur. Maple, ash, oak and beech are particularly susceptible.

In Norway maples over 30 years, for example, dieback of individual branches, or smaller leaves overall, is a common sight. Other trees may begin to prematurely develop their fall colours. Dieback may appear very suddenly or so gradually you may not know it is happening.

The causes of dieback are poorly understood. Root stresses such as soil compaction, poor drainage, site alteration, and high soil temperature are contributing factors, as are viral diseases. Girdling wires and ropes left on after transplanting can also be the culprit.

To prevent dieback, institute a proper watering and fertilization program, as this will promote healthy tree growth. With older trees, avoid changes to drainage patterns or the use of heavy equipment on top of the root systems.

Dog Injury

All evergreens, particularly eastern white cedar, are sensitive to urine from male dogs. Symptoms include rapid browning and blackening of lower

leaves, and a distinctive greasy appearance. Damaged growth does not recover.

To avoid injury, protect the lower portion of the shrubs.

Injury to lawns results from dogs urinating on the lawn killing the above-ground portion of the turf. Symptoms usually include circular or oblong patches of dead turf surrounded by a dark green, more rapidly growing ring of turf. Recovery usually occurs within two to three weeks under favourable moisture conditions. Thorough watering of the damaged spots will help leach salts from the urine. However, severely damaged lawns may have to be renovated.

Edema

Edema is associated with extreme fluctuations in soil moisture. Tiny water-soaked spots first appear on lower leaf surfaces, and later develop into corky ridges. Older leaves with severe edema turn yellow and die. It is most common with ivy geranium and other waxy-leaved annuals.

To prevent edema, avoid fluctuating soil moisture conditions, especially in times of high humidity or low temperature. Replant large plants that dry rapidly into larger containers to minimize this condition.

Fertilizer Injury

Too much fertilizer, or fertilizer that is improperly applied, can cause burning. Not enough fertilizer can result in deficiency symptoms, often seen as an overall yellowing of the leaves or weak, spindly growth.

Frost or Chilling Injury

Frost injury is caused by freezing temperatures after growth has begun. Symptoms are different for different types of plants:

- Annuals: blackened leaves and stems. Poorly hardened off transplants are particularly susceptible.
- Deciduous plants: leaf crinkling and blackened leaf margins.
- Early flowering shrubs: flower buds fail to open or appear tattered and brown along the petal edges.
- Coniferous trees: wilting and possible dying off of young shoots.

Girdling Root

Roots that constrict some part of the base of a tree are called girdling roots. They have become a major problem in the urban landscape, causing the decline of many 25-30 year old Norway and red maples. Nursery grown trees are most susceptible, as they are often cultivated close to the stem or grown in containers, causing small roots to grow tangentially to the trunk. Years later, once both trunk and roots are established, constriction by the tangential roots occurs.

Girdling roots can usually be found within 15 cm of the soil line. Their presence is often indicated by a lack of normal flaring where the trunk meets the roots. Visible symptoms include slow growth over a period of several years, small leaf size, premature autumn colour and dieback. These symptoms do not appear until girdling roots have done irreversible damage. Because the problem is usually restricted to one side of the tree, some branches may die while others remain healthy.

To prevent this problem, remove any spiral-like roots before planting young trees.

Herbicide Injury

Plants can be seriously harmed by accidental exposure to herbicides. Careless application, spray drift or leaching into the root zone are common culprits. The severity and type of damage depends upon the amount and type of herbicide involved. Slight exposure may have no long-term effects at all. Exposure to soil-borne herbicides that are active over a period of months or even years, however, is far more damaging.

Once accidental exposure has occurred, there is little you can do to correct the damage beyond watering and fertilizing to relieve some of the stress to the plant. Prevention is the better practice. Read the herbicide label carefully before using, and follow all instructions. To avoid problems caused by spray drift, do not apply sprays on windy days.

Herbicide-specific symptoms

Growth regulating or phenoxy herbicides such as 2,4-D, meco-

Lawn weed killer (herbicide) injury to rose; healthy foliage is on left.

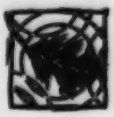
prop and dicamba are commonly used on lawns to control broad-leaved weeds. Plants sensitive to these herbicides include grape, cedar, rose, Manitoba maple and Chinese elm. Symptoms include bent and twisted growth, cupped or hooked leaves, yellow veins and witch's brooms. Conifers are less susceptible, though they may still show yellowing and needle drop, or needle and shoot deformities if new spring growth is involved.

Non-selective herbicides such as paraquat kill leaves and green twigs by direct contact only. Spray droplets cause discrete brown spots similar to leaf spots caused by fungi.

Glyphosate — commonly known by its trade name Roundup — is absorbed by the green tissues of plants, and is then transferred to the root system. Symptoms of damage include yellowing and browning of leaves as well as deformities of new growth.

Beware of non-selective products that are labelled soil sterilants. They contain herbicides such as bromacil, simazine, atrazine, amitrole and diuron. Injury can lead to yellowing and scorching of leaves, purpling of conifer needles, stunting, leaf drop, and dieback. Before using products labelled sterilants on driveways and patios, consider whether roots of nearby trees and shrubs are growing into the area to be treated.

Leaf and Root Scorch



Leaf scorch is a typical example of what can occur when plants have difficulty taking up water. Horse chestnut, oak, harlequin maple, and many others are susceptible, and the problem is most common along city streets.

Leaf scorch is seen most often in mid-August, and usually develops on branches in the upper canopy first. It appears as sudden leaf death or browning, either interveinally or at the margins. A late spring leaf scorch of maple and beech has been attributed to sudden exposure of leaves to full sunlight following a wet, cloudy period.

Root scorch is caused by high levels of salt in the soil, either due to salty irrigation water or salt residues from winter snow removal.

To treat leaf scorch, water deeply once a week during dry spells to minimize stress to the tree.

Natural Gas

Natural gas leaking from a pipeline seriously harms plants.

Pesticide Injury

Spraying pesticides at midday during hot weather may injure the leaves of plants because the plants are already under stress and because the pesticides dry too quickly. The younger, softer growth is most prone to injury. Symptoms appear as marginal leaf burn or as small brown spots throughout the leaf where small, beaded pesticide droplets remained.

Poorly Drained Soil

Most plants do not grow well in poorly drained, waterlogged soil because it lacks the air necessary for healthy root development. Under these conditions, most plants develop poor, weak root systems or very shallow systems that are prone to root rot. Only certain species of woody plants will tolerate these types of conditions: silver maple, willow, dogwoods, balsam fir, black spruce and buttonbush.

Salt Injury

Salt injury from runoff and spray drift caused by passing traffic occurs widely along roads where de-icing salt is used extensively in winter. When plant tissues are wet and temperatures are above freezing, salt enters the plant and accumulates. Typically, the injury

develops on the side of the tree facing the road and on the side of the road facing the prevailing wind.

Salt Spray Injury

Deciduous plants: failure of flower and leaf buds to open, small misshapen leaves, tip dieback and shoot tufting.

Conifers: needles or branchlets turn brown from the tip down and then fall, leaving bare stems.

Salt Injury from Root Uptake

Salt runoff from melting ice and snow from roads and sidewalks will accumulate in the soil until damaging levels are reaches. When a plant takes up too much salt through the root system, leaf size can be reduced, there may be marginal leaf scorch, and leaves can fall prematurely. Trees known to be sensitive include white pine, eastern white cedar, sugar maple, linden, red and white oak and crabapple.

Austrian pine, blue spruce, Russian olive, sumac and Norway maple are quite tolerant.

Walnut Injury

The roots of the butternut and black walnut (though not the English walnut) have a harmful effect on many plants growing within their root zone because of the juglone produced by their roots. Tomato is one of the most susceptible vegetables and will wilt and collapse about the time the fruit begin to size. Other susceptible vegetables include broccoli, Brussels sprouts, cabbage, cauliflower, eggplant, peas, pepper, and potato. Susceptible ornamentals include potentilla, azalea, rhododendron, euonymus and red and white pines.

If you notice that a plant near one of these trees is growing poorly, avoid planting that species in the future. The best remedy may be to remove the tree, but the harmful effects last for more than one year. Using raised beds may be helpful. Another alternative is to plant tolerant plants, including vegetables such as beet, onion, snap beans or sweet corn or ornamentals such as mock oranges, viburnums, honeysuckle, hosta, iris, periwinkle and many others.

For further information, see OMAFRA Factsheet, *Black Walnut Toxicity*, Agdex 246/80, Order No. 84-050.

Wind, Hail or Lightning Injury

Wind or hail injury can cause tattering of leaves on flowers, vegetables, trees and shrubs. Because strong winds are often seen in the spring, young, immature leaves are most susceptible to tattering.

A direct lightning strike to trees can cause serious damage, tearing bark and turning leaves black.

Winter Injury

Many trees and shrubs suffer winter injury because they are only marginally hardy to your area. If the winter is particularly harsh or if there are rapid temperature fluctuations during winter, leaf and flower buds can be killed. The effects are often not evident until late spring, when new growth collapses and inner wood appears black to the core. To guard against this, do not over-fertilize. This will prevent late fall growth and ensure adequate hardening off.

Symptoms of winter injury are varied. Broad-leaved and coniferous evergreens can dry out if planted in exposed, windswept areas. An early warning sign in broad-leaved evergreens is leaf margins that curl down and in. If moisture loss is severe, buds, leaves, needles and small branches eventually turn brown and die. In foundation plantings, water well late in the fall, use thick mulch on the soil surface to insulate the root system, and use protective screens of burlap to reduce exposure.

For young, thin-barked trees such as maples, linden, London plane and flowering cherry, winter injury takes the form of frost cracks or 'south-west injury'. These are long splits in the bark mainly on the south or west side of the trunk. Wrapping the trunk with burlap or painting it with a white latex will reduce this problem.

Many ornamental trees and shrubs may only be marginally hardy to your area. Extreme low temperatures or rapid fluctuations during late winter will result in the death of leaf or flower buds — flower buds are the most sensitive.

To guard against winter injury in all plants, do not over-fertilize; this prevents late fall growth and ensures adequate hardening off. As well, plant any injury prone trees and shrubs in the most protected locations around your property.

GETTING TO THE ROOT OF THE PROBLEM: Diagnosing Plant Problems

The accurate and timely diagnosis of a plant problem is important if the most effective control measures are to be selected and implemented. This, in turn, will minimize the damage to the plant's yield and aesthetic value.

But before you can diagnose a plant problem, you must know the plant's normal appearance and growth pattern. This helps identify problems early on. It is equally important to be able to describe any abnormalities. For example, does the plant show wilt, dieback or discoloration? How are symptoms distributed on the plant, and on other plants in the area? Which species are affected?

Inspect the plant(s) closely for webbing, cast skins, excrement, and other signs of insects, as well as for the pest themselves. Many insects, such as aphids, caterpillars and beetles can easily be seen on plants. Others such as maggots are not likely to be seen until damage is done. If these pests have been a problem in the past, preventive treatment will be required. It is up to you to decide when cultural measures should be supported by chemical control based on the number and type of insect, and the amount of injury present.

Look for moulds, mildews, mushrooms and other spore producing structures; these are the signs of fungi. Look for the presence of a cloudy fluid (bacterial ooze) which might indicate an infectious disease. Generally, damage to leaves cannot be repaired once the plant has been infected.

Bear in mind that weather conditions, site, soil conditions and cultural practices such as pesticide use, fertilizer application, and watering practices will also affect plant growth. A greater discussion of such factors is found in the section on abiotic diseases. They must all be considered when making your diagnosis. Often, it is a combination of factors that create the problem. Plants under stress from poor environmental conditions, for example, are more susceptible to infectious diseases and pests.

To identify the problem, turn first to the appropriate commodity section in this manual. Read through the descriptions of pests and diseases for a particular host until one is found which fits the symptoms you have observed. Both the fruits and ornamentals sections have diagnostic keys to help you in this. For each problem listed in this manual, symptoms are described and control methods provided.

When diagnosing the problem, it is important that you not guess. Only the most common pest problems are listed in this publication. If pests or diseases are encountered which do not fit any listed in this publication, consult other references and specialists. If you are unsure of the diagnosis, consult with other individuals, nurseries or garden centres, horticulturists or the Pest Diagnostic Clinic (see page A-1), for another opinion. You can then decide whether controls are necessary, and if so, which is the best implementation strategy.

• 2 •

INTEGRATED PEST MANAGEMENT

An integrated pest management strategy is one that combines cultural, natural, mechanical and chemical pest control measures. Many of these measures on their own might not provide sufficient control, but in combination, they can reduce the problem to below threshold levels. It is the most effective and environmentally friendly way to minimize problems in your garden.

To plan a successful integrated pest management program, it is important to be familiar both with the plants in your yard and with each one's specific growth requirements. This will help you understand the types of pests most likely to be encountered. Monitoring yard and garden plants frequently throughout the growing season is important. Control is much easier if applied when pest populations are low. As well, healthy plants can withstand pest attack better than plants growing under one of several different environmental stresses.

If you wish to avoid the use of pesticides, carefully select the plants to be grown in your garden, discarding those that will likely require chemical control. For example, avoid hybrid tea roses if you do not wish to spray for blackspot, a disease that will defoliate the plants by mid-to-late summer. Choose instead some of the old-fashioned and species-type roses which are not susceptible.

Cultural Control Methods

The following are cultural pest management options that must be considered if pesticide use is to be minimized or eliminated.

Planning

Companion Planting

Companion planting is the interplanting of crops with other plants thought to repel or prevent pest outbreaks. It is advocated by some as an effective control technique. Unfortunately, a three-year study conducted by staff of the Pest Diagnostic Clinic disproves this belief.

Cabbage, potato, and roses were planted in test plots, and companion plants thought to have insect repellent characteristics were planted around and within them. These included basil, bean, catnip, celery, chives, dill, flax, garlic, geranium, hyssop, horseradish, French and African marigold, nasturtium, parsley, peppermint, sage, tansy, thyme, tomato, and wormwood. All plants were maintained using organic methods.

At the end of the study, it was found that not only were pests generally unaffected by the companion plants, but the companion plants competed with the crops for moisture, nutrients and sunlight. The overall result was reduced crop yield and quality. The only combination which consistently showed some promise was the interplanting of beans and potatoes to reduce injury from Colorado potato beetles and potato leafhoppers.

If you still want to try companion planting as a pest control measure in your garden, several techniques may improve the likelihood of success:

- avoid close planting of highly competitive, densely foliated plants near the crop. For example, avoid planting African marigold, catnip, celery, tansy, tomato, and wormwood as companions unless sufficient space is allowed;
- avoid wormwood, as it produces a chemical substance that reduces the growth of nearby plants;
- avoid companion plants that serve as alternate hosts for pests or diseases of the crop. For example, flea beetles will attack nasturtium as well as cabbage;
- choose plants of aesthetic or culinary importance which could also provide enjoyment or food;
- always leave some of the crop without companion plants to objectively assess whether or not any benefit is resulting from this technique.

Crop Diversity

If a wide variety of plants are grown in a small location, it is more difficult for flying insects to find the right plant on which to feed. For this reason, inter-cropping, or planting alternating varieties of crops, can help reduce pest problems more than if crops are planted in large blocks.

Crop Rotation

Crop rotation involves the planting of non-related crops in a particular location in successive years to minimize the chances of plant-specific disease organisms and pests building up in the soil. This is practical only in large gardens and fields. In small home gardens where rototillers, foot traffic, water and wind readily move soil from one part of the garden to another, it is of limited value. Crop rotation can be effective when certain crops are not planted for two to four years if a particular disease is present, or if certain plants can be successfully planted in remote parts of the garden over successive years.

Crop Selection

Plant breeders have incorporated genetic resistance to various diseases and pests into plants. It is now possible, therefore, to select non-susceptible or resistant plant varieties for your garden. Information on resistant varieties is available from seed catalogues or you can ask nursery or garden centre staff when buying plants.

Plant Hardiness

Not all plants are adapted to all sites, climatic zones, soils, soil pHs, light availability or similar environmental conditions. Plants that grow in unsuitable locations are predisposed to diseases, insects and secondary problems. Woody and herbaceous perennial plants are given hardiness zone ratings that correspond to geographic regions of Ontario and Canada. Buy only those plants that carry a hardiness rating equal to or higher than your location.

Soil Drainage

Good soil drainage is essential as soil saturated with water for several days may cause roots to rot.

Growing

Climate

Climate can greatly influence the health of your garden, and though you have no control over climate, you can be aware of its effects, and take counter-measures when appropriate.

Climate has an effect on insect populations. Fewer generations are produced in cold areas than in warm. Late spring frosts and cold, wet springs are harmful to newly hatched larvae. Heavy rainfall washes small insects such as mites and aphids from plants.

Climate can also influence the severity of a disease. A cool wet spring, for example, increases the severity of Anthracnose on white oak, sycamore, and ash. Frequent summer showers increases the incidence of botrytis on flowers such as tulips, geranium, roses and petunias.

Planting Time

Planting time can be critical to avoid the egg-laying stage of many pests. Optimum times are provided for several garden vegetables (see Table 9, pg. 45).

Planting time can also be critical to minimize the potential for seed and seedling rot. Do not plant large seeded vegetables when the weather is cool and moist, as seed rot can easily overcome the seedlings before they emerge. Wait until the soil is warm and moist.

Depth And Spacing

Planting at the proper depth ensures that seedlings emerge quickly and reduces the risk of damping-off fungi. Even, wide spacing guards against crowding, which can lead to spindly succu-

lent growth, poor ventilation and poor drying conditions. These increase the likelihood that problems such as botrytis, white mould, root rots, damping-off and foliar diseases will develop.

Sanitation

As many insects and diseases overwinter in plant debris and in weeds, the most important sanitation measure involves the regular removal of such material. Pull up all infected plants and weeds promptly and dispose of them outside the garden. They should either be sent to the garbage or buried at least 60 cm deep. Do not put diseased plants in the compost pile, as the sustained high temperatures required to kill problem-causing insects, nematodes, fungi and weed seeds cannot be guaranteed. Some insects overwinter under boards, bricks, stones and similar objects. Remove all such hiding places and store them away from the soil.

Sanitation also includes careful attention to the health of new plants or seeds introduced to your garden. Use only high quality, pest-free and disease-free planting material and seeds.

Tilling

Tilling is important not only to prepare the soil for planting, but to protect the health of your plants. When you work the earth, diseased plant material is incorporated deep into the soil. It is then more rapidly broken down by soil micro-organisms. As a general rule, harmful pathogens survive poorly on rotted plant material or when deep in the soil, and so their levels are effectively reduced.

In addition, tilling exposes soil borne insects, slugs and other invertebrates to adverse weather conditions and to predators such as birds. Many will also be killed by the tilling process itself.

Water

Many diseases are spread by spores which require moisture on leaves and stems to germinate and cause infection. If diseases that are spread by splashing are present in your garden, avoid overhead watering. Water in the morning so that plants dry before nightfall. Do not work in the garden when plants are wet, as you may unwittingly spread disease when you brush against them.

Weed Control

Some weeds serve as reservoirs for insects and diseases. They also compete for nutrients and moisture. Season-long control is recommended.

Harvesting

Crops left too long in the garden are more susceptible to pests or storage rot diseases. It is important therefore both to harvest on time and to properly prepare the crop for storage. Avoid rough handling of fruits and vegetables. This can cause wounds which, in turn, can become infected by secondary disease agents.

Natural Control Methods

Many insect pests have natural enemies that provide some control. They are classified as either predators (Table 3) or parasitoids (Table 4). Predators feed on smaller or weaker insects while parasitoids live in or on the bodies of their hosts. In addition, there are numerous bacteria, fungi and

TABLE 3: Common Predators and Their Prey

PREDATOR	PREY
Lady Beetles and larvae	aphids, mites, thrips and other small insects and insect eggs
Ground beetles	caterpillars and small soft bodied insects
Syrphid flies	aphids and small caterpillars
Lacewing larvae	aphids, insect eggs, thrips and other small insects and larvae
Assassin bugs	aphids, insect eggs, leafhoppers and other small insects and caterpillars
Other true bugs, including predatory stink bugs, pirate bugs, big-eyed bugs and damsel bugs	mites, thrips, aphids and other small insects and larvae, insect eggs and caterpillars
Dragon flies and damsel flies	mosquitoes and other flying insects
Praying mantis	general feeders on a wide variety of insects
Frogs, snakes and mice	a variety of insects

viruses that help reduce pest populations.

Many predators and parasitoids are closely related to the pest species and will look very similar. You would be wise, therefore, to get to know the more common beneficial species in the garden. To determine whether an insect is the problem or part of the solution, look for feeding injury on the plant. Watch the insect to see if it is feeding on the plant or on another insect. Look at its movements; fast-moving insects are generally predators as they need to catch their prey.

Promoting Beneficial Insects

To promote beneficial insects and other organisms in your garden, plant a variety of flowering plants which provide pollen and nectar for adult insects such as parasitic wasps and flies. You must also be careful in your use of pesticides in the garden, as some beneficial insects are killed by smaller doses of insecticides than are required to kill harmful insects. You must also take care to avoid pesticide drift to neighbouring plants which may harbour beneficial insects.

There are several additional tactics that you can use, but there are risks. Mulch between rows of plants provides a natural refuge for predators such as ground beetles, but may also encourage slugs and sowbugs. Native predators such as ladybird beetles can be introduced, but if you buy beetles (*Hippodamia convergens*) imported from the U.S. you will realize little benefit. These beetles are collected while wintering in the mountains of California. Upon release here, they fly away before settling down to feed again. Few if any will remain in your garden to provide the desired control. As well, the ladybird beetle can only help control outbreaks of non-mobile insects such as aphids, and is only effective if introduced before the pest population is well established.

On the other hand, there are beneficial parasitoids and predators that occur naturally in Ontario, are suited for home use, and can be bought from suppliers. Routine introductions are necessary if they are to be successful.

TABLE 4: Common Parasitoids and Their Hosts

PARASITOID	HOST
Ichneumonid wasps	moth, butterfly, beetle and fly larvae and pupae
Braconid wasps	moth, beetle, and fly larvae and various insect pupae and adults

TABLE 5: Parasitoids and Predators that Can Be Purchased

TARGET PEST	PREDATOR or PARASITE
Tetranychus urticae 2-spotted spider mite	*Phytoseiulus persimilis* (a red predatory mite)
Trialeurodes vaporariorum greenhouse whitefly	*Encarsia formosa* (a minute parasitic wasp)
Aphids	*Aphidoletes aphidimyza* (a preditory midge)
Thrips	*Amblyseius cucumeris* *Orius insidiosus*

TABLE 6:
Sources for Beneficial Insects

Plant Products Co. Ltd.
314 Orenda Rd.
Brampton, ON
L6T 1G1
905-793-7000

Natural Insect Control
R.R. #2
Stevensville ON
L0S 1S0
905-382-2904

Safer Ltd.
465 Milner Ave
Scarborough, ON
M1B 2K4
(416) 291-8150

Better Yield Insects
Box 3451, Tecumseh Station
Windsor, ON
N8N 3C4
(519) 727-6108

• 3 •

THE SAFE USE OF PESTICIDES

PESTICIDES IN AN INTEGRATED PEST MANAGEMENT APPROACH

The term pesticide is used to describe a variety of chemicals: insecticides that control insects; fungicides that control diseases caused by fungi; herbicides or weed-killer compounds that control weeds; and others.

Insecticides are specifically formulated to control certain insects. Preventive sprays must be applied before eggs are laid.

Fungicides help control and prevent fungal diseases. Preventive applications are necessary to protect leaves and fruit against infection. If applied after infection takes place, most fungicides can not stop development of the disease, but they may prevent further spread. Repeat applications are required to protect new growth and to renew protection. Fungicides are not harmful to bees. Apply fungicides before rainfall to allow residue time to dry and reduce loss during rainfall.

Only those pesticides with a *Domestic* label are listed in this manual. Products having a commercial, agricultural or restricted label should not be used by the home gardener.

Pesticides are listed by active ingredient only. When buying a pesticide product, select the appropriate material based on active ingredient and label information. There are usually several products that will provide the desired control. Sources for pesticides include local garden centres, hardware stores and similar retail outlets. A list of some products and the active ingredients they contain can be found at the end of this publication. This is not an exhaustive list, and is intended as a guide only.

Systemic Pesticides

A systemic insecticide or fungicide is one that is absorbed by the leaves and stems or by the roots and moves with the sap inside the plant. Sap-sucking insects such as aphids, leafhoppers and leaf-miners are controlled, but beetles, caterpillars and wood borers are not. Dimethoate and oxydemeton-methyl are examples of insecticides having a systemic action. Benomyl and triforine are examples of systemic fungicides. Spray applications are used for systemic leaf and stem pesticides; soil applications deliver systemic root pesticides.

There are advantages to systemic pesticides. Once absorbed, the systemic action of these chemicals counteracts uneven spraying or washing-off by rain. Systemic insecticides can also act as stomach poisons and contact sprays; systemic fungicides can kill fungus spores that land on a treated leaf. However, systemics do not provide permanent control. They gradually breakdown within the plant and are diluted by new plant growth or as they disperse throughout the plant.

Contact Pesticides

A contact insecticide or fungicide is neither absorbed into the plant nor moved through the plant by the sap. As its name implies, it works externally by direct contact with the insect or disease. To be effective therefore, the pesticide must completely cover the plant or affected plant areas. An even application technique is also important to ensure full coverage

and full contact. For example, because two-spotted mites are found primarily on the underside of leaves, coverage of the lower surface is essential to achieving good control.

When plants grow rapidly, applications must be made frequently to protect the new growth.

When To Use Pesticides

It is normal for garden plants to suffer some damage from pests. Healthy plants can withstand pest attack better than those growing under difficult conditions. A few blemishes on fruit or spots on leaves are not usually worth the cost and time spent in control efforts. To be economical, the cost of control should be less than or equal to the loss sustained. It is up to you to decide how much damage you can realistically tolerate or accept before resorting to the use of pesticides.

Nearly all fruit and vegetable crops attract pests that will cause damage if not controlled. Often, the most serious pests are those not native to Canada, but which have been inadvertently introduced. They multiply freely in the absence of predatory and parasitic insects found in their original habitat. Some also find our climate favourable for a rapid increase during the growing season. When this is the case, or if a high yield, high quality crop is your goal, pesticides may be the only valid control strategy available to you.

To use the minimum amount of required pesticide most effectively, you must identify the target pest and determine its life cycle and biology. This includes the damaging stages of the pest, when the pest is present and when it is most vulnerable in its life cycle. All control measures are time-sensitive. To be effective, they must be applied at the proper developmental stage of the pest.

Always select a product recommended for your particular pest problem and spray only the infected plants to avoid killing beneficial insects in the garden. Under no circumstances should you apply a pesticide in the hope of curing an unknown problem. Before using any pesticide, read the label and follow the instructions.

PESTICIDE SAFETY

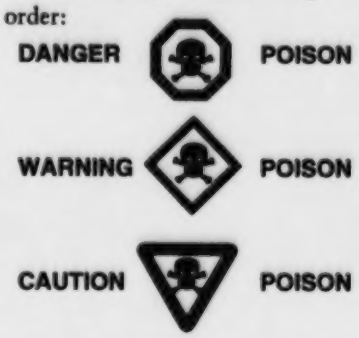
All pesticides have been thoroughly tested for toxicity and environmental impact and are considered safe when used according to label instructions. Pesticides which include the word *Domestic* on the label have been formulated specifically for use in home gardens. They are the only ones that may be legally sold to the home gardener, and they contain no highly toxic chemicals.

Toxicity

When determining the toxicity of a pesticide, three factors are considered: the active ingredient, the concentration of this ingredient, and the substance used to dilute the ingredient. The toxicity level assigned to each product is based on extensive research on its hazards to humans, domestic animals and wildlife. As well, all products must be approved and registered by Health Canada before they can be sold in this country.

This includes approval of any text printed on the product label.

Poison symbols on the label indicate the toxicity in diminishing order:



All liquid pesticides containing more than 10% petroleum distillates must carry the Danger-Poison symbol regardless of the toxicity of the active ingredient. A poison symbol is not required for products of low toxicity.

Pesticides can be used safely if all of the instructions on the label are followed. These include precautions, first aid (where applicable), disposal of empty containers, rate of application and the plants on which the product may be used. Some products have part of the directions on an attached pamphlet or on the carton in which the bottle is packed. Keep the pamphlet or carton with the product.

Several manufacturers may sell the same pesticide, but their labels may not necessarily carry the same information concerning recommended plants and crops. Before you buy a pesticide, read the label to determine whether the intended use is mentioned. It is only safe to apply a chemical on a fruit or vegetable if the label gives directions for that specific crop.

Pesticides Toxic To Bees and Other Animals

Honeybees are important for the pollination of fruit trees, raspberries, strawberries, cucumbers, melons, squash, pumpkins, peas, beans and many ornamental plants. Their presence in your garden is therefore important. *Do NOT apply insecticides to fruits and vegetables in bloom.* The Bees Act makes it an offence to do so. In particular, carbaryl, diazinon, dimethoate, malathion, permethrin and phosmet are not to be used. When insecticide treatment is necessary on an ornamental plant that flowers over a long period, spray or dust in the late evening when bees are not visiting the flowers.

Many pesticides are also toxic to fish, so care must be exercised to prevent them from getting into streams or decorative landscape ponds. After spraying, rinse the sprayer thoroughly with water and apply rinse water to the treated area.

Bacillus thuringiensis is harmless to bees, while rotenone and many fungicides are generally of less potential harm to beneficial insects, animals, and people than insecticides.

Residues on Fruits and Vegetables

Pesticides applied at the recommended rate will take a certain number of days to breakdown into harmless residues. The number of days required between the last application and harvest provide reasonable assurance that the food is safe for consumption. If an overdose is applied, the waiting period is prolonged, although not necessarily in proportion to the amount of the overdose. Pesticides can also damage or kill plants if applied in excess of the recommended rate.

Very low pesticide residues are legally permitted on fruits and vegetables and are called pesticide tolerances. Each pesticide has a specific tolerance on each crop for which it was registered. Excessive pesticide residues can result from not waiting the required number of days to harvest after the application, or from using chemicals at rates exceeding the recommended dosage on the label. Adding extra quantities for "good measure" increases the risk of excessive residues being left on food produced in your garden.

As an additional safety precaution, always wash or peel fruits and vegetables thoroughly before eating, and discard the outside leaves of vegetables such as cabbage and lettuce.

No-Spray Interval

The no-spray interval or use limitation states how many days must pass between the time a pesticide is applied and the time an edible crop can be harvested. It is established to ensure that possible harmful residues on the fruit or vegetable are avoided. The no-spray interval is a crucial measurement, and should always be strictly followed. It is clearly indicated on the pesticide label, and is usually different for each crop and each pesticide.

Responsibility Of The User

As a result of research and legislation, the pesticide label, as prepared by the manufacturer, is a reliable document prescribing the manner by which chemical pesticides can be used safely. Harmful effects to man and his environment are created by careless use of the pesticide. It is the responsibility of the user to handle, store and apply pesticides correctly and safely.

Storage

Keep pesticides out of reach of children and pets. Store them in a locked cupboard away from food, medicine, animal feeds, and cleaning compounds.

Always store pesticides in their original containers, and keep the containers tightly closed. Place them in an area where they are protected from freezing or excessive heat. Store volatile herbicides such as 2,4-D and mecoprop separately from other pesticides.

Dispose of pesticides which are no longer required. Dispose of containers which are unmarked, corroded or damaged.

PESTICIDE SAFETY

- Buy and use only a pesticide with a *Domestic* label. Do not use a product marked *Agricultural, Commercial, Industrial* or *Restricted.*
- Read the entire label and follow the directions carefully. Pay attention to any symbols indicating poison, flammable or explosive products.
- Store pesticides in a locked place, out of reach of children and pets. Do not leave pesticide containers unguarded while spraying. Never transfer the contents to an unlabelled container.
- Apply pesticides only when needed; apply only to the crops listed on the label; and always use the proper application equipment.
- Do not use higher rates than recommended, and always measure the quantity. Do not use milk bottles, soft drink bottles or kitchen utensils for measuring.
- Observe the no-spray interval before harvest for each edible crop.
- To avoid drift, do not spray while windy. Early morning or evening are usually the best times because conditions are calmer.
- Discard empty pesticide containers with the garbage.
- Do not leave pesticide residues in the sprayer; wash them out after use.
- Never eat, drink or smoke while applying pesticides.
- Avoid inhaling sprays or dusts. Always wear protective clothing if the label calls for them.
- If dust or sprays are spilled on clothing or skin, remove clothing immediately and wash contaminated skin with warm soapy water. Clothing should be washed separately from other clothes.
- Wash hands and face after applying pesticides and before eating or smoking.

PRODUCT INFORMATION

Product and Chemical Names

Each chemical registered for controlling pests has a common chemical name which must be stated after the guarantee on the front panel of the label. Manufacturers often give products their own brand name. All recommended products in this publication are given by common chemical names only.

The lists of available insecticides, fungicides and multipurpose mixtures on page A-5 relate the common chemical names to the corresponding products sold in Ontario at time of publication. These lists indicate whether a product is permitted for use on fruit trees, small fruits, grapes, vegetables, ornamentals (flowers, shrubs, trees) or lawns.

Formulations

Domestic use pesticides are available in the following formulations:

- EC: Liquid emulsifiable concentrates for spraying: mix with water.
- L: Liquid suspensions for spraying: mix with water.
- WP: Wettable powders for spraying: mix with water and shake.
- D: Dusts: ready to use in dry form.
- G: Granulars: ready to use in dry form; mostly for soil application.

- **Pressurized sprays:** ready to use as spray.
- **Baits:** ready to use in dry form.

Chemicals applied as a spray are more effective than those applied as a dust and, once they have dried thoroughly, are less likely to be washed off by rain.

Pressurized sprays (aerosols) are convenient for spraying individual plants. They may be uneconomical for general garden use and are usually less effective than conventional sprays.

Multipurpose Mixtures

Multipurpose pesticide mixtures contain several ingredients (usually one or more insecticides and a fungicide). Wherever possible, use individual fungicides or insecticides rather than a multipurpose mixture. This reduces the unnecessary application of an insecticide if a fungicide is all that is required. Most insecticides and fungicides can be mixed in the sprayer if necessary. (See Rate and Method of Application, pg. 26)

Most domestic insecticides and fungicides — except lime sulphur — may be mixed together in a pail or sprayer. Always mix a wettable powder with water first before adding a liquid product.

Resistance to Benomyl Fungicide

By using benomyl exclusively to control a certain disease, the fungus may become resistant with the result that the fungicide loses its effectiveness. By alternating between benomyl and another fungicide the development of resistance can be avoided or delayed.

LABELS

Understanding A Pesticide Label

A pesticide label is a tool — learn to use it. Information on the label includes:

1. Trade name: each company can assign its own name to a product. Pesticides with the same ingredients can have different trade names.
2. Use category: pesticides for use in the home garden are labelled *Domestic*.
3. Formulation: pesticides can be available in many different formulations. Choose the best formulation for your needs. The different formulations are described on pg. 24.
4. Symbol warning: the symbol warning tells how hazardous the product is. Descriptions of the symbol warnings are on pg. 22.
5. P.C.P. Act Registration Number: any pesticide used in Canada must carry a P.C.P. number.

Sample Label

John Doe's BUG KILLER (1)
INSECTICIDE
Liquid Emulsifiable Concentrate (3)
DOMESTIC (2)
Guarantee: (common chemical name)% (6)
Reg. No. 00000
PEST CONTROL PRODUCT ACT (5)
(or P.C.P. Act)
DANGER **POISON** (4)
Read the label before using
Net Contents: 500 x millilitres (7)
John Doe Co. Ltd., Ontarioville (8)

(9) DIRECTIONS FOR USE on apple, pear, cabbage, cucumber, tomato, birch, rose and annual flowers (except petunia).
To control aphids, caterpillars, flea beetles, leafhoppers, cucumber beetles and tomato hornworms, apply when many insects are noticed and repeat as necessary. For coddling moth on apple and pear, apply in late June and repeat every 7 days until mid-August. For birch (12) leafminer, apply when young leaves unfold and repeat in early July.
Mix 15 mL (1 tablespoonful) in 5 L of water and spray all foliage and fruit thoroughly.
(13) Do not apply later than 7 days before harvest on apple and pear, and not later than 3 days before harvest on cabbage, cucumber and tomato. Do not use on any other edible crops.
(10) PRECAUTION: Keep out of reach of children. Hazardous if swallowed, inhaled or absorbed through skin. Avoid breathing spray mist and contact with skin and eyes. Wash after use and before eating and smoking. Avoid contamination of food, feed and water; this product is poisonous to fish. To avoid killing bees, spray flowers only in late evening when bees are in their hives. Do not spray fruit trees while in bloom.
(11) FIRST AID: If swallowed, DO NOT induce vomiting but rush patient to nearest hospital taking this labelled container with you. If in eyes, flush with plenty of water for 15 minutes and get medical attention. If on skin, wash with soap and water. This product contains petroleum distillates. The chemical may cause cholinesterase inhibition; atropine is antidotal.
Dispose of empty container with regular garbage; do not reuse.

6. Guarantee: the common names of chemicals in the pesticide are listed under the guarantee. Be sure you are buying or using the correct product. Recommendations in this guide are given in terms of common name because there are too many trade names to list.
7. Net Contents: The amount of pesticide in the package is listed on the label. Buy only as much as you will use within a year or two.
8. Manufacturer's or Formulator's name and address: the manufacturer or formulator can be contacted if more information on the pesticide is needed.
9. Use Pattern: a pesticide can only be used for the crops and pests listed on the label, especially if they are food crops.
10. Precautions: if the precautions on the label are followed no adverse effects should occur.
11. First Aid: labels have immediate first aid information on them. If someone is poisoned consult the label and call the poison control centre.
12. Directions for Use: every label states how much pesticide can be used and how to use it properly. Follow these directions.
13. Use Limitations: the use limitations state how many days must pass between the time of applying the pesticide and the time the crop is harvested (pre-harvest interval). It is not safe to harvest and use the crop before the required number of days has passed.

PESTICIDE APPLICATION

Treatment Time

The time of application stated throughout this publication applies to the part of Ontario south of the line from Ottawa to Sudbury. Even in that area, the emergence of insects varies according to temperature and growth conditions. These differences are greatest in the spring and gradually disappear by midsummer. In addition, weather conditions vary from year to year and some judgement is needed regarding the timing of treatments. The same principle applies to the northern parts of Ontario where spring is late.

Treatment times and intervals are usually based on the life cycle of a pest, or on the residual activity of the pesticide.

Rate and Method of Application

Always use the rate of pesticide specified on the label. Higher rates may cause injury to plants, kill beneficial insects and leave harmful residues on edible crops. Lower rates may result in unsatisfactory pest control.

The rate of application for spraying pesticides depends on the concentration of the active ingredient in the product. Different rates of the same product may be needed for the control of various insects or diseases. Spray mixtures using very hard water have a shorter period of effectiveness than sprays made with medium-hard or soft water. If your tap water is very hard, use rain water if possible.

Spray Applications

Rates for spray pesticides are expressed by volume of water. Read the label carefully before mixing any pesticide with water, to ensure that the correct rate is used. When applying the spray, the leaves, stem and fruit should be covered from all sides until they drip. Do not apply sprays when temperatures are 27°C or higher, as plant injury is more likely to occur. If it is necessary to spray during hot weather, do so in the morning or in the evening. Plant injury is also more likely when the air is very humid, causing slow drying of the spray.

Soil or Lawn Applications

The rates for soil or lawn applications are based on the surface area. The volume of water is not important as long as it is sufficient to cover the area. The rate of application depends primarily on the type of sprayer used because coarse sprays apply more liquid than fine sprays.

Dust Applications

Dusts are purchased ready to use. The application should cover all parts of the plant with a thin layer of dust. It is essential that dusting be done when the air is calm. This is usually more likely to be the case in the early morning or in the evening.

EQUIPMENT

Sprayers

The following types of sprayers are available:

- Portable tank sprayers with 4-15 L capacity suitable for medium and large gardens. They operate by pumping air into the tank before spraying is started or during the spraying operation. Keeping the air pressure as high as possible improves coverage and penetration within the plant canopy.
- Bottle-type sprayers with 0.5-1 L capacity for small gardens and for spraying a few plants. They operate by continuous squeezing of the handle during spraying. This type of sprayer is not suited where there is dense foliage or where the pest or disease is on the lower leaf surface.
- Hose-end sprayers operated by the water pressure in the garden hose. The highly concentrated spray mixture is siphoned from the jar into the water stream from the hose. Hose-end sprayers do not work well if the water pressure is low or for wettable powders at rates of more than 100 mL per 5 L of water. A potential problem with this type of sprayer concerns the valve in the head. If this becomes defective, the concentration of the spray may be higher or lower than intended. Test the accuracy of the sprayer at least once a year by spraying a certain volume of water into a pail and comparing it with the measurement on the jar.

It is recommended that you do not use the same sprayer that was used for weed killers to apply insecticides and fungicides because it is very difficult to adequately clean weed killers from a sprayer. Doing so may cause severe injury to plants. If this is not possible and only one sprayer is available, clean the hose and tank very carefully to make sure that all traces of herbicide are removed. After rinsing, add 1 mL of household ammonia or baking soda per L of detergent solution, and let this mixture stand overnight in both the tank and hose. The next day, empty the sprayer by spraying the solution out through the nozzle, and rinse the tank with clean water.

Dusters

If dust is to be used, a proper duster is required. Excessive quantities of dust may damage the plants and leave harmful residues on fruits and vegetables. Some dusts are sold in plastic squeeze-duster containers which work well. Shaker-cans with holes in the lid apply too much dust on the upper side of the foliage and none on the underside; however, they are suitable for applying insecticides on the soil. Burlap bags are not suitable as dusters; they create an inhalation hazard and apply far too much pesticide.

Use and Maintenance of Equipment

The purpose of dusters and sprayers is to distribute pesticide on affected plants or soil thoroughly and evenly. Poor pest control is often the result of improper or poor distribution.

The kind of pesticide application equipment you will need depends on the type and size of the garden. For a few low-growing vegetables and ornamentals, a simple duster or dusts in shaker packages are satisfactory. For fruit trees and large plantings, a compressed air or knapsack sprayer will be required. The rates applied with these sprayers can be closely controlled. Their range can be extended to cover tall trees by adding sections to the sprayer wand or by using ladders. Trees over 7.5 m usually require a high-pressure power spray for thorough coverage. Since power equipment is expensive, it is usually more economical to hire a commercial pest control firm.

Garden hose sprayer attachments are not recommended because the amounts they apply are variable and difficult to regulate. If there is no other alternative, see pg. 28 for details on calibrating a hose-end sprayer.

Do not use garden sprayers in the house. If pesticides are to be used indoors, apply them with a small hand sprayer, a paint brush, or an aerosol can.

If sprayers are properly maintained, they can give many years of service. Some pesticides are corrosive to metal parts, so it is important to rinse and wash out the tank with detergent or soap solution after each use. Leave the tank uncapped and upended during storage to allow it to dry without rusting.

Worn shut-off valves and leaky hoses or joints should be replaced immediately. Faulty sprayers increase the hazard to the applicator and give poor results.

Equipment Calibration

As we have noted, pesticides are recommended at specified amounts per area or per volume (e.g., 10 g/100 m^2, 10 mL/100 m^2, 5 mL/L). To know exactly how much pesticide is being applied, it is essential that your equipment be properly calibrated.

HOSE-END SPRAYERS

Hose-end sprayers are not recommended for the application of pesticides because most do not give an accurate dosage and few can be used to apply wettable powders. If a hose-end sprayer is your only option, however, there are steps you can take to improve its effectiveness.

- Before connecting the hose-end sprayer be sure it is in good working order and the siphoning tube, nozzle and filter screens are clean.
- Open the tap fully while spraying with a hose-end sprayer.
- Avoid running the water from other taps on the premises to help maintain a more constant water pressure.
- After use, flush both the sprayer and the garden hose with water.

If an instruction sheet on calibration was included with your hose-end sprayer, use those instructions. Otherwise follow these steps:

Calibration for Ground Spraying

Do a test spray first, using water only, to determine the correct application speed, as follows:

1. Connect the garden hose to the water tap and hose-end sprayer.
2. Adjust the sprayer nozzle to the desired setting (narrow stream, fan shaped, or mist).
3. Fill the sprayer bottle with water. Ink or food colour can be added to make it easier to see the amount of water in the bottle.
4. Mark off a 10 m x 10 m area using a measuring tape, pegs, and string.
5. Turn the tap on fully.
6. Walk back and forth over the marked-off area, spraying until the area is covered. Remember the pace of walking and do it at the same rate thereafter.
7. Turn the water tap off and read the amount of liquid left in the sprayer bottle. The difference between this reading and the full mark is the amount of coloured water (pesticide) used.
8. If the pesticide container label indicated to use 10 mL/100 m^2, and 10 mL were used, then this was the right amount. If more or less than 10 mL/100 m^2 were used, adjust the application rate accordingly by walking faster or slower while spraying.
9. Empty the coloured water from the spray bottle and refill it with the required amount of pesticide and water to treat the infested area. Turn the water tap on fully and spray the infested area. Thoroughly rinse the sprayer and sprayer hose with water before storing it.

Calibration When Spraying Trees and Shrubs

Do a test spray first, using water only to determine the concentration of pesticide you will have to use, as follows:

1. Fill the sprayer bottle according to the manufacturer's instructions. Where the instructions state to use a pesticide concentrate, replace that amount with coloured water. Measure all liquids that go into the sprayer bottle and calculate the percentage of coloured water in the total volume of liquids in the sprayer bottle.
2. Connect the hose-end sprayer to the garden hose, with the spray deflector removed (if possible). Spray into a pail marked at 1 L intervals and fill the pail to the 2 L mark. Turn off the water.
3. Measure the amount of coloured water (pesticide) left in the sprayer bottle and divide by 2 to determine the amount used per litre of spray in the pail. Multiply this amount by the percentage of coloured water in the bottle. This is how much coloured water (pesticide) was used in 1 L of spray. Compare this with the recommended dosage of pesticide on the label. If more pesticide was used than recommended, dilute the mixture in the sprayer bottle. If less pesticide was used than recommended, increase the concentration of pesticide in the sprayer bottle.

PRESSURE SPRAYERS

When filling the sprayer always use a funnel with a very fine screen to filter both the pesticide and the water. This prevents debris from getting into the sprayer and clogging the nozzle.

Do a test spray first, using water only, to determine the correct pressure and application speed as follows:

1. Mark off a 10 m x 10 m area with a measuring tape, pegs, and string.
2. Measure 4 L of water into the

sprayer (1 Imperial gallon sprayer holds 4.5 L, 1 American gallon holds 3.8 L).

3. Pump air into the sprayer. The higher the air pressure inside the tank, the faster the spray will be discharged. Use high pressure to spray for insects and diseases, low pressure for weeds.
4. Adjust the nozzle to desired pattern. (For weeds, a nozzle with a flat spray pattern is used. For insects and diseases, use a nozzle that delivers a hollow cone spray pattern.)
5. Spray the measured area by walking over it and moving the wand slowly from side to side about 30 cm above ground level.
6. When the area is sprayed, release the pressure by slowly unscrewing the sprayer lid. Let's assume that all the water was used up. Now it is known that, if that pressure and walking pace are maintained, it takes 4 L to spray 100 m^2.
7. If the label states to use 5 mL of pesticide/L of water, and to use 4 L of mixed spray/100 m^2, then add 20 mL of pesticide to the 4 L of water and spray it on 100 m^2.
8. If an upright plant, shrub, or tree is to be sprayed, spray it with enough water to wet the leaves and stems to determine how much water is required. Then add the proper amount of pesticide. For example, it was determined that it takes 3 L to spray the tree. The label says to use 10 mL/L of water. Mix 30 mL (3 L x 10 mL/L) of pesticide in 3 L of water.
9. When the pesticide label says that the product should be applied 'to the point of runoff', apply the spray until it drips off the leaves and runs down the branches and stem. This method is used only with ornamentals, not food plants.
10. Thoroughly rinse the sprayer before storing it upside down and open.

Granular or Dust Applications

Granular and dust formulations of pesticides do not require mixing and often come in convenient ready-to-use packages. Rates for granular or dust formulations are expressed in several different ways.

The label may recommend a pesticide rate based on the length of a row. For example, a label may specify using 40 g of the formulation on a row 10 m long. If the row is 5 m long, apply half that amount of pesticide (in this case 20 g).

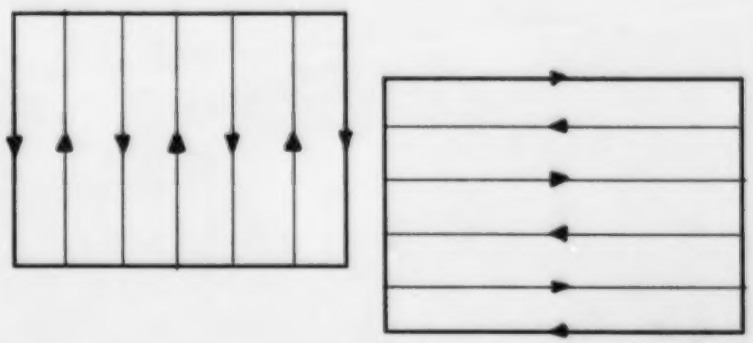
Recommended rates of granular or dust formulations may be based on a given area. For example, a label may specify using 300 g/100 m^2. To determine the amount of pesticide that will be required:

1. Calculate the area to be treated by multiplying the length by the width (e.g., Area = 2 m x 5 m = 10 m^2).
2. Carefully calculate the amount of pesticide needed for this area as follows: Recommended rate x Area to be treated = 300 g/100 m^2 x 10 m^2 = 30 g/100 m^2
3. Apply the calculated amount of pesticide evenly over the area.

If a fertilizer type of spreader is used to apply granules on a lawn, first measure the rate of output of the spreader. To do this:

1. Either attach a plastic bag onto the spreader or put a piece of paper or plastic on the ground to catch the granules. This piece should be at least as wide as the spreader and 2 m long. A longer piece of plastic or paper will help to determine the output more accurately.
2. Put a small, evenly distributed amount of the pesticide in the spreader.
3. Next, determine the correct adjustment for the spreader and the correct walking speed. Keeping the spreader closed,

FIGURE A: Pattern for Pesticide Application on a Lawn



start walking approximately 3 m in front of the paper or plastic sheet. When reaching the sheet, without changing the pace, open the spreader so that the pesticide drops onto the sheet. Close the spreader after walking 2 m (about 2 large steps).

4. Weigh the amount of pesticide on the paper.
5. Measure the width of the spreader and the length covered to determine the area treated with the chemical (width of spreader x length travelled). For example, if the spreader is 1 m wide and the paper 2 m long, an area of 1 x 2 = 2 m^2 was treated.
6. Determine the amount (g) applied on 1 m^2. Divide the amount in step 4 by the area calculated in step 5. For example, if 200 g were applied on 2 m^2, the spreader was dropping 200 ÷ 2 = 100 g/m^2.
7. Check the label to see if the correct amount of pesticide was applied. If the label reads: 5 kg/100 m^2, apply 50 g/m^2 (not 100 g/m^2). In the example, too much pesticide is being applied. Adjust spreader to a slower output or increase walking speed to reduce the pesticide rate and redo the test run until the output rate is correct. To ensure an even coverage, go over the lawn twice using half the amount of pesticide each time in a criss-cross pattern. First walk lengthways up and down the lawn (Figure A), then walk back and forth across the width of the lawn. For the above example, 25 g/m^2 would be applied each time.
8. If the spreader cannot be adjusted, measure the area to be treated, weigh out the required amount of chemical and evenly distribute it by hand using rubber gloves. A metric weighing scale and metric measuring spoons are available and should be purchased. See pg. A-11 for Imperial to metric conversions.

• 4 •

LOOK TO THE GROUND: A WORD ABOUT SOIL

Soil anchors and supports plants and acts as a reservoir for water and nutrients. It is made up of minerals, organic matter, air and water. The exact nature and chemistry of these components, and their weight in the mixture, determine a soil's suitability to support plant growth.

Loamy, well-structured soils, high in organic matter and fertility, are the most desirable. Soils that don't meet these criteria can often be improved by the addition of fertilizer and organic material such as peat, manure or compost. Soils most likely to respond to the addition of organic material are heavy clays and sandy soils. A test for organic matter is available and advisable if you are concerned about soil structure but is not an accredited test.

THE NATURE OF SOIL

Minerals and Soil Texture

The mineral component of a soil is made up of clay, silt and sand, often referred to as fine, medium and coarse size particles respectively. The percentage of each of these determines the texture of a soil.

- Clay soils contain a larger percentage of clay (fine) particles.
- Loam soils contain a balanced proportion of sand, silt and clay particles.
- Sandy soils contain mostly sand (coarse) particles.

Soil texture is difficult to change. It is a basic soil property. However, if yours is a heavy clay garden soil, you can slowly alter its texture by adding sand and organic matter such as compost, manure or peat moss over successive seasons.

Soil Structure

Soil structure refers to the way soil particles cling to each other in clumps or aggregates. A well-structured soil contains small aggregates and is easy to work. Each aggregate holds water and nutrients, and the air between the aggregates allows excess water to drain away.

Poor soil structure reduces root growth of seedlings, making them more susceptible to drought. It also results in soil compaction after rain or when walked on, and this leads to poor water penetration and a lack of oxygen. Plants that grow in such soil are smaller, less vigorous, more prone to

drought and lower yielding than those grown in healthier soil.

Good soil crumbles when forked or spaded. If a soil breaks into blocky clods with flat surfaces and sharp corners, soil structure is poor. You can improve your soil's structure by adding organic material such as peat moss, manure or compost. It is also a good idea to seed a garden with grass if it has been under cultivation for several years and the soil breaks into clods. Grass has an extensive root system that grows throughout the top 15 cm layer of soil and breaks up the clods. The roots also release substances that promote the bonding of smaller aggregates. In addition, grass roots, shoots and clippings provide plenty of organic matter to improve soil structure. To achieve the best results, a garden should remain seeded for two to three years.

Organic Matter

Organic matter in soil is mainly decayed plant material. In most soils, it accounts for up to 10% of the mixture. Soils with 17% or more of their weight as organic matter are called organic soils. Generally, the darker the soil, the higher the organic matter content.

Organic matter plays an important role in soil structure. It acts as a cementing agent to bind soil particles together. It is also the most chemically active component of soil and is a source of plant nutrients.

The surface of organic matter contains exchange sites that attract and hold plant nutrients. As nutrients are removed from the soil by plant roots, they are replenished by nutrients from these exchange sites. When fertilizer is applied, the exchange sites are saturated, creating a reservoir of nutrients for future use.

A garden that is cultivated year after year without the regular addition of compost or manure soon begins to lose organic matter. Over time, the soil becomes tight and compacts very easily. The quality of plant growth is reduced.

Clay Colloids

Like organic matter, clay colloids act as reservoirs of plant nutrients. The glue-like minerals (colloid means glue) hold onto nutrients and release them into the soil as plant roots take up nutrients and water. A productive soil, therefore, should contain a balance of organic matter and clay.

Soil Fertility

Soil fertility is an important part of good lawn and garden management. Good fertility promotes plant growth, reduces the susceptibility of plants to insect and disease damage, improves drought tolerance and reduces weed populations in lawns. Usually, fertility problems are easily corrected. However to ensure successful gardening, it is also important to:

(i) select the most suitable plant varieties;

(ii) control insects, diseases and weeds; and

(iii) provide adequate water and light.

Soil pH

Soil pH is a measure of the acidity or alkalinity of a soil. A pH of 7.0 is neutral. A pH below 7.0 is acidic and above 7.0 is alkaline. Soil pH has an important effect on the availability of many nutrients. As the soil becomes more basic (high pH), the availability of nutrients such as iron and manganese is reduced. Most plants grow well in soils with pH values of 6.0 to 7.5. However, some plants such as Rhododendron, Azalea, heathers, blueberries, and pin oak require acid soils and only grow well below pH 5.5. In most of Southern Ontario, soils are neutral to alkaline, though there are areas where soils are too acidic for optimum growth of most plants. Many soils on the Canadian Shield are low in pH.

You can get a general idea of your soil's pH by using pH strip papers that change colour to reflect pH levels. A low pH condition can be corrected by adding agricultural dolomitic limestone to the soil. Because of the chemical nature of high-alkaline soils, however, it is very difficult to do the opposite and lower a high pH condition. Success can be achieved on medium and course textured soils with the addition of sulphur. If your soil has a high pH, and you wish to grow ericaceous plants and blueberries, it is best to build raised beds or to excavate the existing soil and replace it with a mixture of peat moss, composted bark or oak leaves and sandy topsoil. Sulphur should be incorporated into the soil mix and added yearly to keep the pH low.

Soluble Salts

Soluble salts are dissolved mineral ions in the soil. Some occur naturally, some come from fertilizers and some are the result of the decomposition of manure, mushroom compost or similar organic matter. Ontario soils are naturally low in soluble salts. Where the level of soluble salts is high, there have usually been excessive applications of fertilizers, manure or mushroom compost.

High concentrations of soluble salts can affect seed germination and plant growth. When soluble salts increase, water absorption by plant roots decreases, because the water is held in the soil with greater force. When salt levels are high, plants suffer abiotic drought.

Wilting of plants during the brightest and warmest times of day even though the soil may be moist is usually the first symptom of a high salt content. Plant growth will also be reduced, and leaves often appear small and dark green. As salt levels continue to increase, the tips and edges of leaves burn, and the root system is damaged. Plant growth is affected most under higher temperatures and low moisture periods. Damage from soluble salts does not include roadside salt spray damage to trees and shrubs.

Some plants such as begonias, impatiens, cucumbers and lettuce, are more sensitive to soluble salts than others. Seedlings are more sensitive than older plants, and will die if soluble salts are excessive.

Soluble salts can be measured in the laboratory by measuring the electrical conductivity of a soil-water slurry. Table 7 provides an interpretation of soil conductivity readings in a 2:1 water:soil paste, the procedure recommended by the OMAFRA accredited soil testing programme.

TABLE 7: Soil Conductivity (soluble salts) Interpretation

Conductivity mS/cm	Rating	Plant Response
0 - 0.25	Low	Suitable for most plants if recommended fertilizers are used
0.26 - 0.45	Medium	Same as above
0.46 -0.70	High	May reduce emergence and cause slight to severe damage to salt sensitive plants
0.71 - 1.0	Excessive	May prevent emergence and cause slight to severe damage to most plants

PLANT NUTRITION

Plants take up their water and nutrients from the soil. For healthy plant growth, therefore, the soil must be adequately supplied with both. A number of nutrients are essential for plant growth, and plants take up these various elements at different rates depending on the stage of growth.

In the spring and summer, when plants are in a vegetative stage, great levels of nitrogen and phosphorus are required. At flowering and fruiting, higher levels of potassium and calcium are needed, and very little nitrogen is absorbed. Perennial plants as well as trees, shrubs and grass will absorb a high amount of nitrogen from the soil and store it both in the roots and crown. This will be used for mobilization in the spring when the rate of growth is very rapid.

Major Nutrients and Micronutrients

Nutrients fall into two categories depending on the amount used by the plant. Major plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium and sulphur. Of these, nitrogen, phosphorus and potassium are most likely to be deficient in lawn and garden soils. Calcium and magnesium deficiencies are rarely seen except in low pH or sandy soils.

Micronutrients, although required in small quantities, are equally important and essential to plant growth and development. These nutrients include zinc, manganese, iron, copper and boron. Generally, they are not deficient in lawn and garden soils. Depending on the plant species, micronutrient deficiencies may occur in sandy soils, in back-filled areas, or when soils are too alkaline.

Lime-induced iron chlorosis is the most common micronutrient deficiency problem in home gardens, especially with azaleas, rhododendrons, blueberries, Hydrangea macrophylla, and pin oak. Leaves yellow, though the veins remain green; as the problem worsens, leaf tissue becomes

almost white, with burning around the edges.

FERTILIZERS

Think of fertilizers as plant food. By that definition, any material added to a soil to enhance the nutrition of plants could be considered a fertilizer. This includes commercially prepared fertilizers, and organic materials such as manure, mushroom compost, fishmeal, or blood and bone meal.

Organic Fertilizers

Organic fertilizers include manure and compost, and their value to gardens and lawns is often underestimated. Manure and compost contain many micronutrients and organic matter, which helps to build and maintain soil structure. They also contain all the nutrients required for plant growth. The problem is that they may not necessarily be present in the proportions required by all species or soil types.

Cow and Sheep Manure

Well composted cow and sheep manure are readily available in most garden centres. It is applied at a rate of 120-250 kg manure per 1000 m^2 of soil. Turn under manure with 9.75 kg of 0-20-0 fertilizer (spread the manure on the soil, broadcast fertilizer overtop and then work both into the soil surface with a spade or fork). Fresh poultry, rabbit, and sheep manure are much higher in nutrients and soluble salts than livestock manure, so reduce the rate of application to one-third, compost it thoroughly first, or apply it in the fall.

Leaves, Lawn Clippings, Peat, Sawdust

This type of organic mulch is broken down by micro-organisms in the soil. This process, unfortunately, uses important nitrogen stores required for plant growth. To prevent this, turn the mulch under with 12.5 kg of 15-15-15 fertilizer per 100 m^2 of soil.

Compost

Compost bins can be bought at most hardware stores and garden centres, or you can build your own of wire fencing supported by posts, boards or masonry. Place the bin in a semi-shaded and well-drained spot protected from cold winds. Do not place it under trees where roots will grow up into the compost. Line the bottom of the bin with straw to soak up any liquid that may run out.

Alternate layers of organic matter with soil. For each 15 cm of organic matter, packed down, provide 3 cm of soil. This will add micro-organisms to the compost.

If compost is composed largely of straw, sawdust or fallen leaves, apply a nitrogen fertilizer such as 10-6-4 to speed up the breakdown of the material and therefore improve the nutrient content of the compost. A rate of 360 g fertilizer per 35-40 L of organic matter is recommended. Manure can be used instead of fertilizer and dolomitic limestone (60 g per 40 L compost) added to counteract acidity and speed up decomposition.

Compost made up largely of kitchen scraps and yard waste such as grass clippings or spent flower blooms is nutrient-rich. Additional fertilizer is rarely required, and if used, not more than 40-50 g fertilizer per 35-40 L of organic matter is recommended.

Compost can be built up to 1.0-1.5 metres. It is helpful to have more than one bin to produce compost throughout the year. Keep it moist but not soggy, and turn it two to three times every two weeks to hasten decomposition and reduce odour. Compost started in fall is ready to be used in June.

Chemical Fertilizers

Most garden and lawn soils in new subdivisions are deficient in several essential plant nutrients, especially phosphorus and potassium. This is particularly true when the topsoil has been disturbed and redistributed after house construction. By using the proper chemical fertilizer, these nutrients can be added to the soil at the optimum rate, thereby improving plant growth. The best method of determining the kind and amount of nutrient required is a soil test.

Established garden and lawn soils can also benefit from the application of a low rate of a balanced chemical fertilizer. This will help replace nutrients used by the previous crop or during the previous growing season. Once soil fertility is high, however, you only need to apply enough fertilizer to maintain fertility levels.

Fertilizer Grade and Ratio

All fertilizers sold in Canada are sold by grade, which tells you the nutrient percentage of the product

by weight. It is expressed as a set of three numbers: total Nitrogen (N), available phosphate (P_2O_5) and soluble Potash (K_2O). A 10-6-4 fertilizer, therefore, contains 10% N, 6% (P_2O_5), and 4% (K_2O).

Grade is one of the most important factors to consider when buying fertilizer; it is certainly more important than the trade name. A fertilizer under the trade name "Tree Food", with a grade of 30-10-10, can be used anywhere that a 30-10-10 fertilizer grade is required.

Ratio defines the proportion of nutrients in the fertilizer. Thus, 7-7-7 is in a 1:1:1 ratio, while 21-7-7 is in a 3:1:1 ratio and 4-8-12 is in a 1:2:3 ratio.

Substituting Fertilizer Analysis

When the required fertilizer grade is unavailable, it is possible to substitute with another of similar ratio, but you must first calculate the amount of nutrients required. This is done by multiplying the amount of fertilizer applied by the grade for each nutrient, and dividing by 100.

For example: 10 kilograms of 10-6-4 provides:

$$\text{Nitrogen: } \frac{10 \text{ kg} \times 10\%}{100} = 1.0 \text{ kg Nitrogen}$$

$$\text{Phosphate: } \frac{10 \text{ kg} \times 6\%}{100} = 0.6 \text{ kg Phosphate}$$

$$\text{Potash: } \frac{10 \text{ kg} \times 4\%}{100} = 0.4 \text{ kg Potash}$$

Let's say, for example, that it has been recommended that you apply 5 kg per 100 m of 7-7-7 grade fertilizer, but only a 10-10-10 product is available. This will be suitable, as each fertilizer has a ratio of 1: 1: 1. You must, however, correct for the amount of fertilizer that you use. With this example, the recommended 7-7-7 fertilizer will supply 0.35 kg of nitrogen (5 kg of fertilizer x 7% nitrogen), 0.35 kg of phosphate and 0.35 kg of potash. If substituting a 10-10-10 fertilizer, 3.5 kg per 100 m will provide you with the same amount of nutrients.

You can use these calculations to substitute other grades of fertilizers. Try to substitute a grade of the same, or similar, ratio. Some common substitutions are usually listed on the back of your soil test report form.

Toxicity of Fertilizers

All fertilizers are toxic if too much or too concentrated an amount is applied. As well, some nutrients — especially micronutrients — are toxic even at low levels. A fertilizer's solubility can also play a role in determining its toxicity to plants. For example, ammonium nitrate and calcium nitrate are both used in chemical fertilizers as a nitrogen source. Ammonium nitrate, however, dissolves far more quickly when it comes into contact with moist soil than does calcium nitrate. If you accidentally spill fertilizer on your lawn or garden, therefore, the chance of damage to plants is far greater if ammonium nitrate is used.

Chemical vs. Organic Fertilizers

Chemical fertilizers are usually much cheaper per kilogram of actual nutrient than are manure or compost. As well, they provide you a balanced nutrient content, and allow you to choose the grade and ratio needed for your garden.

Manure is generally more expensive, and a considerable amount needs to be incorporated into the soil to meet the needs of the crop. However, manure has the added benefit of providing a good source of organic matter that maintains soil structure and increases earthworm and microbial activity. And when purchased in pre-bagged amounts at a garden centre, its nutrient content is usually balanced. For those wishing to avoid chemically manufactured forms of nitrogen, therefore, manure is a viable option.

The use of home compost as the sole fertilizer in your garden is not as viable. This is because it is extremely difficult to know its nutrient make-up. Nutrient content also varies according to the ingredients used. As a source of organic matter, however, home compost is excellent.

SOIL TESTING

Home gardeners in Ontario spend a lot of money on fertilizers each year. This is done in the hopes of achieving high yielding fruit and vegetable crops, colourful flower gardens, and vigorous trees and shrubs. These gardeners will only be successful, however, if their fertilizer use is reflective of the natural fertility level of the garden soils and the amount of compost and manure also being incorporated into the soil.

Soil testing is a way to help gardeners understand the nature and fertility of their soil. It also helps protect the environment by providing gardeners with fertilizer recommendations reflective of their particular garden. Plants respond in a very positive way to nitrogen, phosphorus and potassium when applied to low fertility soils. For many established gardens, where there have been regular applications of fertilizer, manure and compost over the years, anything but a minimal application can prove to be excessive. Plants become too tall and leafy, flower poorly, set fruit poorly and are easily bent down in wind or heavy rains. Soil testing is the most accurate tool available to determine the amounts of fertilizer required for optimum plant nutrition while minimizing the possible leaching of excess nutrients.

OMAFRA Accredited Soil Testing Programme

The OMAFRA accredited soil testing programme for home gardens and lawns provides recommendations for nitrogen, phosphate and potash along with a recommendation for the amount of lime to apply if required. The recommendations are designed to provide good plant growth while preventing or correcting nutrient deficiencies. Sampling every two or three years is recommended.

Several laboratories are accredited to provide a soil testing service to home gardeners. See appendix A on pg. A-1. Soil sample boxes and information sheets, a list of accredited laboratories and information on the cost of soil testing may be obtained from any local office of the Ontario Ministry of Agriculture, Food and Rural Affairs.

Soil Sampling Procedure:

1. Use a soil sampling tube, shovel or spade.
2. Remove four or five cores or slices, 15 cm deep, from different locations in the garden. (Parts of a lawn or garden that differ in soil texture or in fertilization practices should be sampled separately.)
3. Mix cores together, and break up any lumps.
4. Draw the sample for analysis from the combined cores.

"Not every soil can bear all things."

-Virgil

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VEGETABLES

GROWING TIPS

Vegetables grown in a well-managed home garden are fresher and more flavourful, cost less than their store-bought counterparts, and are often of better nutritive value. Many can also be grown without pesticides.

Planning

When planning your garden, consider first the types of vegetables you want to grow, as well as specific varieties and quantities. Planting dates, location, spacing and fertilizer needs may then be determined. For an average garden of 3 m by 7.5 m, 15 to 20 different vegetables can be grown.

Choose vegetables and varieties your family prefers. If space is limited, consider growing compact, high yielding plants such as peppers, eggplants and bush tomatoes. Growing plants vertically will also help. Cucumbers, peas, and pole beans, for example, can be trained to climb a trellis. Vine tomatoes can be staked. If yours is a large garden, you may instead wish to plant space-consuming plants such as squash and melons.

PLANT SELECTION

Divide your garden into four sections, each of roughly the same size.

Section 1: Perennial crops

Example: asparagus, rhubarb, perennial herbs, strawberries and raspberries.

Section 2: Long-season crops

Example: sweet corn, eggplants,

tomatoes, peppers, melons, leeks, onions, squash, potatoes and turnips (rutabaga). Because of its shading effect, you may wish to plant sweet corn elsewhere in your garden.

Section 3: Short-season crops

Example: beans, beets, carrots, lettuce, radish, spinach, Swiss chard, dill and peas. When planning this section, keep in mind that two crops can be harvested in one season. Plant a second crop of beans after spinach, cress or lettuce are finished. Plant a second crop of carrots or beans after the first have been harvested.

Section 4: Cole crops

Example: early and late cabbage, turnips, kohlrabi (long-season crops) and collards, kale, Brussels sprouts, broccoli and cauliflower (short-season crops). It is rare that two generations of a cole crop can be grown in one season. Instead, cole crops are often grown sequentially: a short-season crop is planted first, and a long-season crop planted later in the summer.

PLANTING DATES

Vegetables are planted at different dates and some can be planted more than once a season.

Cool season crops can be seeded or planted outdoors in early spring, when the weather is still cool. Example: beets, Swiss chard, cabbage, collards, broccoli, Brussels sprouts, lettuce, onions, parsley, peas, potatoes, radish, spinach, turnips and carrots.

Warm season crops must be seeded or planted outdoors after the soil has become warm. A temperature of 14-15 °C in the top 10-12 cm is a good guideline. For recommended planting dates, see Table 9, pg. 45. Warm season crops can also be started indoors and transplanted when the soil is warm enough. Example: beans, beets, eggplant, sweet corn, cucumbers, okra, squash and melons. Beans and sweet corn, however, are not suitable for transplanting.

- Long-season crops require two to four months before harvest.
- Short-season crops require less than two months before harvest.
- Perennial crops grow year after year without replanting.

Use this knowledge to organize the timing of your planting season. You can plant cabbages, lettuce, beans, beets, carrots, green onions and spinach twice in one season; radishes can be planted three times. Plant vegetables such as broccoli, cauliflower, multiplier onions, lettuce, radish, spinach, beans and sweet corn at different times in different areas to have a constant supply. Follow early broccoli with cauliflower, and peas with Brussels sprouts or late broccoli.

FIGURE 8: Creating a raised bed for drainage.

LOCATION

There are several basic guidelines when both choosing the location of your garden and determining the site for each vegetable:

- Locate your vegetable garden in an area that receives at least six hours of sunlight, preferably during the warmest part of the day. Do not plant in shaded areas near buildings or large trees.
- Space rows according to crop and tilling equipment used. Cooking onions, green onions, radishes or carrots, for example, do not produce large plants or leaves. They can therefore be planted with a narrow row spacing of 30 cm. Beans, corn or tomatoes, however, should be planted in rows 90 cm apart. If the tilling is to be done with a hoe, you will most likely want to minimize tilling space and so will place rows as close together as possible. This is also true for those with a small garden plot. If, however, you plan to use a rototiller, then consider planting rows 80-90 cm apart.
- Plant rows running north and south to take maximum advan-

tage of the sunlight. Rows running east and west may be necessary in sloping land to avoid soil erosion.

- Plant sweet corn at back of garden next to trellised cucumbers and tomatoes to minimize shade to rest of garden.
- Mix short and long season crops together in same or alternate rows to maximize growing area. Example: Grow lettuce and radishes (fast growers) between rows of cabbage or tomatoes (slower growers).

DRAINAGE

One of the most important factors in a successful garden is good soil drainage. Without it, plants fail to thrive because their roots are not able to absorb the oxygen required for respiration.

When necessary, drainage can be improved by creating raised beds. To do so, prepare the soil as you normally would with organic matter and fertilizer. Dig up soil from paths placed about 1 m apart and throw this onto the middle, where the beds will be. The soil can be held in place by boards. Rake the surface smooth. See Figure B.

Plant Hardiness

Some vegetables fare better whatever the soil, planting and temperature conditions. Leaf lettuce will succeed under cooler and wetter conditions than will head lettuce. Corn and potatoes may kill to ground level if frosted, but will regrow —albeit with a later maturity date and lower yield — if they are in fertile soil and have storage material left in the seed.

FROST HARDY

Frost hardy plants can resist a few degrees of frost (-2 °C to -4 °C) if the temperature change is not too sudden. Most of them require cool growing weather and germinate well at lower soil temperatures. They are often sown well ahead of frost-tender types.

Examples: broccoli, Brussels sprouts, cabbage, Chinese cabbage, cress, kohlrabi, leaf lettuce, onions and related crops, parsley, radish, rhubarb, peas, spinach, turnip, kale, parsnip.

SEMI-FROST HARDY

Semi-frost hardy plants can tolerate temperatures of 0 °C to -2 °C for short periods of time, though injury may occur to top growth. Many of them are sown almost as early as frost hardy ones because they remain safely in the soil during cold periods before emerging above the ground. Most semi-frost hardy types can be sown fairly early in the season.

Examples: asparagus, beets, carrot, cauliflower, celery, Swiss chard, endive, head lettuce, herbs (many), potato.

SEMI-FROST TENDER

These plants will suffer injury to leaves and stems if exposed to temperatures of 0° to -1° C for more than several hours. Young shoot tips and buds, however, can usually withstand the cold.

Examples: snap bean, tomato, sweet corn.

FROST TENDER

Frost tender plants are killed when exposed to temperatures of 0 °C to -1 °C for more than several hours. Leaves, stems, buds and shoots are easily blackened.

Examples: bean, corn, cucumber, eggplant, muskmelon, okra, peppers, pumpkin, squash and watermelon.

Transplants

Avid gardeners may start seeds indoors although transplants are best grown in a greenhouse, where ventilation, water, and light are easily controlled. Buying from a garden centre is most cost and time effective.

Consult Table 9, pg. 45 for the number of weeks required to grow transplants.

MEDIA

Seeds are grown in a medium that must have good water drainage and adequate water holding capacity. It should also be free of herbicides, weeds, insects, and diseases. Pasteurized soil-based media or soil-free mixtures are recommended. Mixes containing unpasteurized garden soil are not recommended as diseases can develop.

It is possible to home-pasteurize your transplant medium. Place 10 cm of moist garden soil in cans or metal trays and bake in oven at 100 °C or "warm" for one hour. Do not exceed this time and temperature. Clay pots and metal tools can be treated in the same way. Used plastic flats and pots should be scrubbed and sterilized by soaking in a solution of 1 part household bleach to 9 parts water. Peat moss should not be heated in the oven, as it will smoulder.

For a homemade soil-free mixture, combine the following:

2 L horticultural vermiculite

2 L horticultural perlite

6 L shredded peat moss

16 g (0-20-0) superphosphate

32 g ground limestone

24 g (33-0-0) ammonium nitrate or 64 g (5-10-5) fertilizer

CONTAINERS

Grow transplants in plastic pots or cell-pack containers (individual plastic vacuum-formed containers) to minimize transplant shock. Some root systems are more sensitive than others to transplanting. Cucurbits such as cucumbers, squashes, watermelons, and muskmelons should be planted in peat pellets or pressed peat pots that can be planted along with the vegetable. Peppers, eggplants, tomatoes and all cole crops can be transplanted bare-rooted.

SEEDING

Sow seeds in moist —not waterlogged — medium following directions on seed packet. Most seeds will germinate at a depth of 0.5 cm. The larger the seed, the deeper it needs to be planted. Except for warm season cucurbits, sow seeds in rows, planting 8-10 seeds per 2.5 cm. Place the trays in plastic bags or cover them with a sheet of glass. When seedlings are 2-3 cm tall, transfer them to individual containers. Warm season cucurbits should be sown in containers. Plant 2-3 seeds per container, then cover with plastic bags or a sheet of glass. When seedlings emerge, thin them to one per container.

LIGHTING

Do not put seedling trays under artificial lights until seeds germinate. After that, remove bags or cover and place lights 10 cm above the seedlings. As they grow, adjust the lights 12-15 cm above leaves. Use horticultural fluorescent lamps, available at garden centres, to provide 12-14 hours of sunlight and temperatures of 20-22 °C.

Transplants will grow under a combination of standard cool white and daylight fluorescent lamps. High light levels, however, remain a requirement to avoid stretching; this occurs when the plant grows long and spindly as it attempts to reach the available light source.

WATERING

Keep soil moist with room temperature water, never allowing it to dry or the seedling to wilt. Do not leave pots sitting in a tray of water; too much water is as bad as not enough. Soil-free media that forms a loose ball when compressed lightly in the palm of your hand is at the proper moisture level.

PREVENTING DISEASES AND PESTS

The most common problem affecting transplants is damping-off, caused by fungi that attack seedlings at or just below the soil line. The stem may turn black and the seedlings will fall over.

Bacterial diseases of tomato, pepper and some cole crops can be transmitted through the seeds, but this is rare. Viral diseases are usually only a problem outdoors, where they are transmitted by insects. A few can also be transmitted by humans handling healthy plants after having touched infected ones.

Prevent pests and diseases by taking the following measures:

- Use new containers and media every year.
- Use sterilized tools and media.
- Use resistant varieties.
- Do not overwater.
- Do not use contaminated plants.
- Practice good sanitation by disposing of plant debris.
- Do not allow the end of the hose to touch the ground of the greenhouse where it can pick up pathogens.

HARDENING OFF

Two weeks before transplanting, seedlings should be hardened off by placing them outside on nice days. This serves to toughen stems and leaves so that the plants are more tolerant of the elements. They are not as easily wind-tattered, sunburned or dried out, and can more easily withstand the move from the protected indoor environment. Hardening off also includes reducing the amount of water and fertilizer.

When placing transplants outside, do not put them directly in the sun at first, as the leaves will burn. They should also be placed against the house or in a similarly protected area. Coldframes, made of wood, metal, concrete or brick and covered by a hinged, removable panel of glass or clear plastic, can be used for long-term, outside storage.

Hardening off is particularly important when growing transplants at home, as these seedlings are often very tender.

TRANSPLANTING

Water seedlings thoroughly a few hours before transplanting, which is best performed in dull weather or in the evening when soil is moist. Plant most vegetables deeply (up to the first true leaves) to provide stability, and firmly press the soil around the root ball. This creates a slight depression at the base of the plant to trap water. Cover peat pots completely with soil or the root zone will dehydrate. If your garden is sloped, position your plants in the direction of the prevailing wind to prevent stem breakage. Fertilize with a starter solution of 15-30-15, 10-52–10, or 20-20-20 at the rate of 2 g per litre of water. For the first few days, shade the plants by placing cardboard or paper on their south side. Water them once or twice in the first week.

ROW COVERS

Row covers can be used to improve earliness of crops by increasing the above-ground temperature and protecting young transplants from wind damage. There are two basic types of row covers:

Floating covers are made of polypropylene or polyester and are laid on top of the transplants, in direct contact with them. These covers are well suited for vine crops and other low growing crops.

Mini-tunnels are made of white or clear polyethylene and are supported over the crop on wire hoops, with the edges of the cover buried. The plastic has perforations to allow ventilation. Earliness of cucumbers, eggplants and melons is increased.

Heat can build up inside both types of covers and damage the plants. Temperatures should be monitored and covers removed or ventilated when the temperature exceeds 32-35 °C.

Mulch

Mulch controls weeds and soil temperature, conserves moisture , reduces nutrient leaching, and prevents soil compaction and root damage from hoeing. There are two basic types of mulch: organic mulches that cool the soil, and plastic ones that warm it. The basic types are discussed below.

PLASTIC MULCHES

Polyethylene film is the most effective mulch available. It accelerates crop maturity and reduces garden maintenance. It also allows later-maturing vegetables to grow where the season is short. Tomatoes, peppers, eggplants, squashes, watermelons, muskmelons, cucumbers, beans, sweet corn, spinach, onions, and cabbages respond to polyethylene mulch.

There are three types of polyethylene mulch or film: clear, black, and brown. Brown and black films control weeds and keep the soil warm. Clear film, because it allows the passage of light, cannot control weeds. Brown film does not have to be removed after harvest, as do the others, because it breaks down by the time many crops are harvested. If mulch film is not available, green, blue, or black garbage bags can be split and used in small areas.

Roll the film over the prepared row and secure by digging 10-12 cm of soil under each side and anchoring the edges with it. Plant transplants or seeds through a hole punched with a sharp trowel or shovel. Water as usual.

ORGANIC MULCHES

There are many benefits to organic mulch: it contains plant nutrients; improves the soil's structure, making it easier to till; increases water-holding capacity; and aids in development of beneficial micro-organisms.

Organic mulches can be composted bark chips, cocoa beans, compost, ground corncobs, chopped cornstalks, grass clippings, leaves, manure, shredded newspaper, hay, sawdust, straw, and wood chips. Do not use evergreen needles, as their high acidity will lower the soil pH.

Wait until seeds have germinated and the garden has been weeded and lightly cultivated be-

fore applying organic mulches. Fine, heavy mulches such as sawdust and ground corncobs can be applied 5-8 cm thick; rough, light mulches such as straw and hay can be 8-15 cm thick. Remove mulches or incorporate them into the soil at the end of the season. If you have used a large quantity of organic mulch, add nitrogen fertilizer to the soil before digging it in.

Live Mulches and Green Manure Crop

Ryegrass, clover or oats can be seeded in between the rows as cover crops to control weeds and protect from soil erosion. At the end of the season, the cover crop can be incorporated into the soil as a green manure, adding organic matter. Seed cover crops in late July or after harvest and incorporate in the fall or early spring. Seed 1.5-2.5 kg rye or oats per 100 m of soil.

Cover crops can be used along with plastic mulches, seeded in between the rows. Mow them periodically.

Fertilizer

Commercial fertilizers are usually incorporated into the soil in early spring. However, many vegetables benefit from a second application given at specific times of plant development. Corn, cucumbers, squash, melons, broccoli, and cabbage respond to a further application of 225 g ammonium nitrate (33-0-0) per 30 m of row, four to six weeks after planting. A second application of fertilizer should be applied to tomato and pepper only after the first flower cluster has set fruit, otherwise the plants become too vegetative and fruit is late in setting, resulting in a very poor yield.

For a more detailed discussion of fertilizers, see Chapter 4: A Word About Soils, page 34.

Water

Your vegetable garden will need about 2.5 cm rain every 10-15 days for optimum growth. This amount — roughly 22 L water per 1 m soil — allows water to penetrate the soil to about 15 cm and provide nutrients to the root system. If there is not enough rain to meet this need, you will have to supplement.

One heavy watering is better than frequent light waterings, as these encourage shallow rooting, putting plants at a disadvantage. Water in the morning, because wet leaves at night will encourage spread of disease. Sandy soils require more frequent waterings than heavier soil.

If you prefer to use an irrigation system, soaker hoses and trickle irrigation are suitable for the home garden. They can be placed on one side of the crop row or under the mulch and can be used at night with less risk of disease than when using sprinklers. Less water is also required because more goes directly to the roots.

To determine how long it will take for your irrigation system to provide 2.5 cm of water, place a can under the sprinkler or hose and time how long it takes for 2.5 cm to accumulate. Irrigate this length of time in the future.

TABLE 8: Recommended Vegetable Varieties and Quantities

VEGETABLE	VARIETIES	SEED REQUIRED PER 30 METRES	POSSIBLE YIELD PER 30 METRES
Asparagus	Viking (purchase 1 year old crowns whenever possible	1 pkt	600 spears
Bean, Bush	Contender, Rodcor (yellow), Goldrush (yellow), Greencrop, Improved Tendergreen	280 g	54 kg
Bean, Lima	Derby, fordhook bush 242	450 g (bush lima)	11 kg (bush lima) 22 kg (pole lima)
Bean, Pole	Blue Lake, Scarlet Runner, King of the garden (lima), Romano	225 g	22 kg (shelled lima) 68 kg (snap)
Beet	Detroit Dark Red, Early Wonder, King Red, Ruby Queen (canning), Formanova (cylinder), Burpee's Golden Beet	28 g	500 roots
Broccoli, Early	Green Comet	1 pkt (indoors) 2 pkts (outdoors)	45 kg
Broccoli, Late	Emperor, Paragon, Premium Crop	2 pkts	45 kg
Brussel Sprouts	Lunet, Jade Cross, Prince Marvel, Valiant	3 pkts	34 kg
Cabbage, Early	Emerald Acre, Early Marvel, Tucana	1 pkt (indoors) 2 pkts (outdoors)	50 heads
Cabbage, Late	Bartolo, Safekeeper (storage), Bingo	2 pkts	50 heads
Carrot	Nantes, Red Cored Chantenay, Royal	14 g	500 roots
Cauliflower, Early	Extra Early Snowball, Polar Express, Snow Crown	1 pkt (indoors)	50 heads
Cauliflower, Late	Andes, Self Blanche, White Sails, White Rock	2 pkts	50 head
Celery	Florida 683, Surepak, Ventura (resistant to bolting)	1 pkt (indoors) 2 pkts (outdoors)	200 plants
Chard, Swiss	Vulcan, Fordhook Giant, Lu Cullus Light Green	28 g	100 plants
Chinese Cabbage	Michihli	3 pkts	100 heads
Corn, Early	Patton, Earlivee, Seneca Horizon (yellow), Speedy Sweet, Ivanhoe (bicolour), Jester	225 g	130 ears
Corn, Late	Sir Galahad, Delectable, Flavorvee, Cabaret, Calico Belle (bicolour), Merlin	225 g	100 ears
Cucumber	Burpless Hybrid, Marketmore 76, Dasher II, Pikrite, Salty	14 g	54 kg
Eggplant	Black Magic, Dusky Hybrid, Black Bell	1 pkt	400 fruits
Endive, Early	Full Heart Batavian Escarole	2 pkts	130 plants
Endive, Late	Green Curled, Salad King, Frisan	2 pkts	130 plants
Herbs	Dill, Cress (broad-leaved)	2 pkts	400 plants
	Summer Savory, Sage, Thyme, etc.	3 pkts	200 plants
Kale	Green Curled Scotch	3 pkts	50 plants
Kohlrabi	Early White Vienna, Grand Duke	14 g	300 heads
Leek	Alaska, Titan	14 g	200 heads
Lettuce, Head (Early)	Bib, Ithaca	2 pkts	100 heads

continued on next page

VEGETABLE	VARIETIES	SEED REQUIRED PER 30 METRES	POSSIBLE YIELD PER 30 METRES
Lettuce, Head (Late)	Buttercrunch, Green Lake, Ithaca, Montello	2 pkts	100 heads
Lettuce, Leaf	Black seeded Simpson (very early), Red Rapids, Red Sails, Slo Bolt, Parris Island (Romaine)	2 pkts	100 heads
Muskmelon	Burpee Hybrid, Pulsar, Primo	1 pkt	400 fruits
Okra	Annie Oakley, Clemson Spineless, Perkins, Mammoth Long Pod, Burgundy	28 g	600 pods
Onion (Seed Or Set)	Mustang, Benny's Red (red), Carmen (red), Canada Maple (yellow), Sweet Sandwich (yellow)	14 g	600 bulbs
Onion (Bunching)	Japanese Bunching, southport White globe (early)	14 g	700 tops
Onion, Transplants	Fiesta, Sweet Spanish, Cima	2 pkts	300 bulbs
Parsley	Champion Moss Curled, Curlina, Darki	1 pkt	300 bunches
Parsnip	All-America, Harris Model, Hollow Crowned Improved	14 g	300 roots
Peas	Spring, Green Arrow, Lincoln (Homesteader), Little Marvel (early), Olympia, Sugar Snap (snow pea)	450 g	9 – 18 kg
Pepper	Red Start, Merlin, Bell Boy (late), California Wonder, Klondike Boy (yellow), Long Red Cayenne (hot), Super Set (early-sweet)	1 pkt	300 fruits
Potato	Jemseg (extra early), Superior (early), Kennebec (main season), Chieftain (red skinned), Shepody, Yukon Gold (yellow fleshed)	6.8 kg	68 kg
Pumpkin	Connecticut Field, Howden, Small Sugar, Spooky, Sweetie Pie	56 g	200 fruits
Radish	Cherry Belle, Champion, Belle Glade	28 g	1200 roots
Rhubarb	Valentine, Victoria	25 roots	300 stalks
Rutabaga	Laurentian	1 pkt	200 roots
Spinach, Early	Vienna, Long Standing Bloomsdale, Melody	28 g	200 plants
Spinach, Late	Long Standing Bloomsdale, Melody, Virginia Savoy	28 g	200 plants
Squash, Summer	Cocozelle, White Scallop, Sunburst	56 g	200 fruits
Squash, Winter	Buttercup, Spaghetti, Golden Hubbard, Green Hubbard, Autumn Queen, Waltham Butternut, Sweet Mama, Delicata, Table Gold	56 g	250 fruits
Tomato, Unstaked	Basketvee, Bush Beefsteak (early), Sunrise, Red Rider Glamour, Pik Red	2 pkts	180 kg
Tomato, Staked	Better Boy, Ultra Girl, Ultra Magnum, Lemon Boy (yellow)	1 pkt	180 kg
Turnip, Summer	Purple Top, White Globe, Shogoin	1 pkt	300 roots
Watermelon	Crimson Sweet, Sugar Baby (both open pollinated)	42 g	200 fruits
Zucchini	Blackjack	1 pkt	500 fruit

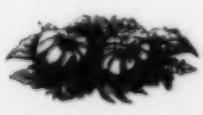


TABLE 9: Planting Recommendations For Vegetable Crops

In Northern Ontario, seed or transplant closer to or after the later date recommended under "Recommended dates for outdoor seeding and transplanting.

VEGETABLE	Distance between rows (cm)	Distance between plants (cm)	Planting depth (cm)	Recommended dates for outdoor:		Time from Indoor Seed to Outdoor Transplant	Days to Harvest	Average Sowings	REMARKS
				Seeding	Transplanting				
Asparagus	100	30	2.5-4	May 15-30	April 15-May 10	1 year	3 years	–	Transplant seedlings to permanent bed the next spring, before the buds on the crown break dormancy.
Bean, Bush	60	5-8	4-5	May 5-June 15	–	–	50-70	4	Does best on warm loam where nights are dry. Plants bear more pods if picked young.
Bean, Lima	60	5	4-5	May 20-30	–	–	70-80	1	Warm climate preferred.
Bean, Pole	60-90	20-30	4-5	May 5-25	–	–	60-70	1	Grows best when trained on fence or poles.
Beet	45-60	3-5	1.5	Apr. 20-June 1	–	–	55-70	Many	Use thinned plants for greens.
Broccoli (early)	60-75	45-60	0.5 - 1.5 or transplants	–	April 25-May 5	4-6 weeks	60-70	1	In spring transplant as early as possible to miss summer heat. (Late sowing also helps plants escape summer heat at heading time.) Always cut broccoli when the individual buds on the clusters are still tight. After the central head is harvested, small side branches develop and may be picked every few days.
Broccoli (late)	60-75	45-60	0.5 - 1.5 or transplants	May 5-July 10	June 1 - July 15	–	60-70	1	
Brussel Sprouts	60	60	0.5	–	April 5-25	4-6 weeks	70+	2	Nip out growing points of plants once Sprouts start to form.
Cabbage (early)	60-75	45	0.5-1.5	–	April 5-25	4-6 weeks	70-80	2	Heavy feeders. Grow on rich soil. Bolds more easily when exposed to prolonged cool weather, so do not plant earlier than recommended.
Cabbage (late)	60-75	45-60	0.5-1.5	May 10-June 1	May 24-June 10	4-6 weeks	85+	–	Do not attempt late sowing in districts with short growing seasons.
Carrot	45-60	3-5	1.5	April 15-June 1	–	–	65-75	many	Thin at bunching stage. In heavy soils use short varieties.
Cauliflower (early)	60-75	45-60	0.5-1.5 or transplants	–	May 5-10	4-6 weeks	60-75	1	Tie leaves over heads when nearing maturity. Purple type does not need tying. Harvest before heads become coarse and "ricey".

continued on next page

VEGETABLE	Distance between rows (cm)	Distance between plants (cm)	Planting depth (cm)	Recommended dates for outdoor:		Time from Indoor Seed to Outdoor Transplant	Days to Harvest	Average Sowings	REMARKS
				Seeding	Transplanting				
Cauliflower (late)	60-75	45-60	0.5-1.5 or transplants	May 5-June 20	June 25-July 25	4-6 weeks	60-70	1	Can be transplanted well into June for fall maturing.
Celery (early)	60-90	15	0.3	–	May 5-15	10-12 weeks	120-150	1	Seed heavily as germination is often poor. Do not sow late in districts with short growing seasons.
Celery (late)	60-90	15	0.3	April 10-20	July 1-10	10-12 weeks	120-150	1	
Chard, Swiss	60	20-30	1.5	April 10-June 1	–	–	55+	many	Harvest outside stalks only.
Chinese Cabbage	60-75	20-30	0.6	April 10-June 1	–	–	75+	1	Sow late as it grows best in the fall.
Corn (early)	75-90	15-25	2.5	April 25-July 1	–	–	60-70	2	Plant at least three or four rows of the same variety to ensure good pollination and kernel formation. Plant early and late varieties at the same time. Make successive plantings of late varieties every 15-20 days. If only one early or late variety is replanted, do it one week after first planting.
Corn (late)	75-90	15-25	2.5	April25-June 15	–	–	80-95	2	
Cucumber	120-150	30-60	1.5-2.5	June 1-10	June 10-20	4 weeks	60-70	2	If started indoors, plant in pots. Harvest before fruits yellow.
Eggplant	60	60	1.5	–	June 1-14	8-10 weeks	70-80	1	Grow in a protected site in rich, warm soil. Harvest before the glossy stem colour becomes dull and the flesh tough.
Endive (early)	60	20-30	0.5-1	April 20-May 10	–	–	90+	2	Sow in the spring as early as possible or grow as a fall crop.
Endive (late)	60	20-30	0.5-1	June 1-20	–	–	90+	2	Grows best in the fall.
Herbs (dill, cress)	60	7	0.5-1	May 10-30	–	–	As required	1	Easy to grow.
Herbs (summer savory, sage, thyme)	50	15	0.5-1	May 10-30	–	–	As required	2	Barely cover seed.
Kale	70	60	0.5	April 1-June 1	–	–	55-60	1	Light autumn frost improves the quality.

continued on next page

VEGETABLE	Distance between rows (cm)	Distance between plants (cm)	Planting depth (cm)	Recommended dates for outdoor:		Time from Indoor Seed to Outdoor Transplant	Days to Harvest	Average Sowings	REMARKS
				Seeding	Transplanting				
Kohlrabi	60	10	2.5	April 30-July 1	–	–	60+	3	Use when stems are slightly smaller than tennis balls.
Leek	60	1.5	1.2	May 10-20	May 15-June 25	8 weeks	150	1	Can be grown in the garden until late fall; very frost hardy.
Lettuce, head (early and late)	45-60	30	0.5-1	April 1-10; June 25- July 5	April 1-20	8-10 weeks	75-85	Many	Sow either early or late, as it grows best if heading does not occur during period of summer heat.
Lettuce, leaf	45-60	15-30	0.5-1	April 1-August 1	–	–	40-45	Many	Extra tender if not thinned.
Muskmelon	120	30-60	1.5-2.5	–	May 20-June 10	4-6 weeks	80-120	2	Guard against cucumber beetle.
Okra	60	30	2.5	–	May 25-June 1	4 weeks	50-60	2	Required heat and a lot of attention. Used to flavour soup and stews. Pick young tender pods every other day.
Onion (seed or set)	45-60	5-8	1.5-3	April 5-25	–	4 weeks		2	Sets favoured for early bulbs and green onions.
Onion (transplants)	45-60	8-10	–	–	April 10-20	10 weeks	115-135	1	
Parsley	60	10	0.5-1	May 10-30	May 10-30	–	110	1	When potted, also used during winter to garnish food.
Parsnip	45-90	2.5-5	2.5-5	April 10-May 25	–	–	60-75	2-3	Must use fresh seeds each year. Very slow to germinate.
Peas	45-90	2.5-5	2.5-5	April 10-May 25	–	–	60-75	2.3	Sow early. Will not grow successfully in summer heat.
Pepper	60	60	1.5	–	June 1-June 20	7-10 weeks	65-75	1	Needs a protected site with rich warm soil. Green peppers are peppers that have not fully ripened.
Potato (early)	75-90	25-30	10	April 5-May5	–	–	80-100	1	Fertilize according to soil test. If a test is not available, work 80 mg/m of row of 8-16-16 before planting. When the crop is 15-30 cm high, broadcast 15 g/m of row of 34-0-0 and hill the crop immediately. Control insects. Keep harvested tubers from light or skins will turn green. Later varieties store better than early ones. Yukon gold is an excellent keeper.
Potato (late)	75-90	25-30	10	May 1-June 1	–	–	110-130	1	

continued on next page

VEGETABLE	Distance between rows (cm)	Distance between plants (cm)	Planting depth (cm)	Recommended dates for outdoor:		Time from Indoor Seed to Outdoor Transplant	Days to Harvest	Average Sowings	REMARKS
				Seeding	Transplanting				
Pumpkin	180-250	60-120	2.5	May 25-June 15	–	–	100-110	2	Place plenty of manure under trench in which seed is sown. Dust with rotenone for cucumber beetle.
Radish	30	2.5	1.2	April 1-May 1 or Aug. 1-Sept. 1	–	–	25-35	4	Will grow right up to the first snow flurries. Lack of water causes no flavour and woody texture.
Rhubarb	90	90	–	–	April 14-May 1		2-3 years	–	Requires a rich topsoil.
Spinach (early)	45-60	10-15	1.5-2.5	April 1-20	–	–	40-45	2	Does not grow on hot, sandy soil. Does best under cool conditions and on rich loam.
Spinach (late)	45-60	10-15	1.5-2.5	July 15-Aug. 1	–	–	40-45	2	
Squash	180-250	60-120	2-3	May 25-June 10	–	–	95-110	2	Dust with rotenone for cucumber beetle.
Tomato (unstaked)	90	90	1.2 or transplants	–	May 15-June 15	6-8 weeks	62-66	2	Use a 1-2-3 fertilizer ratio as a side dressing after first flower cluster has set fruit.
Tomato (staked)	60	45-60	1.2	–	May 15-June 16	6-8 weeks	75-82	1	
Turnip	45-60	15-20	0.5-1	June 10-July 1	–	–	50-55	1	Best as a fall crop. Will grow to first snow. Keeps well in fruit cellar.
Watermelon	120-180	30-60	2-3	–	May 25-June 10	4-5 weeks	80-95	2	Use a 1-2-3 fertilizer ratio at planting time.

INSECT AND DISEASE CONTROL ON VEGETABLES

The battle against the development and spread of insects and diseases begins with the use of cultural methods such as the proper timing of seeding or planting, and the removal of diseased plants and crop refuse after harvest. A number of cultural methods are described on pg. 17, and they are recommended whenever possible. For vegetable gardens in particular, it is also possible to use hot-water treated seeds. These have been treated to prevent diseases from being introduced to crops such as tomato and cole crops.

In many situations, however, gardeners cannot rely on cultural control alone. Judicious use of a pesticide may then be required. At other times, no satisfactory control exists, be it cultural or chemical.

Recommended Pesticides

For a full discussion of pesticide use, including resistance to benomyl fungicide, rate of application, and mixing products together, see pg. 21.

The recommended pesticides on the following pages are listed in alphabetical order, not in order of preference. They are identified by the common chemical name of their active ingredient(s). The lists of pesticides on pg. A-5 relate the common chemical names to the products sold in Ontario at the time of publication. Not all recommended pesticides are registered for all vegetables; read product label carefully.

Pesticides and The No-spray Interval Before Harvest

The no-spray interval before harvesting vegetables refers to the minimum safe period of time between the last application of a pesticide and the harvest of the crops. Vegetables may not be sprayed or dusted closer to harvest than this interval, in order to avoid harmful residues on the produce. This period varies for each product and each kind of vegetable. Consult the product label for the no-spray interval and follow the directions.

* Only available in multipurpose mixtures

** See "Resistance to benomyl", pg. 25

*** Wash vegetables treated with maneb before eating. Discard water used for boiling.

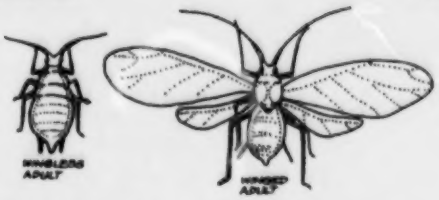
DESCRIPTIONS AND TREATMENTS

Insects and diseases are listed under each vegetable. If, however, you cannot find the pest to suit your symptoms, look in the "Many Vegetables" section below.

Many Vegetables

APHIDS

see Plate 1



Aphids or plant lice are small, soft-bodied, sap-sucking insects. They are green, red or black, and usually found in clusters on young shoots. Aphids leave a sticky deposit on leaves known as honeydew, which later becomes sooty black. Heavily infested shoots will curl up. All vegetables are susceptible, but aphids are most common on broad (Windsor) beans, broccoli, Brussels sprouts, cabbage, cauliflower, celery, cucumber, eggplant, lettuce, melon, pea, pepper, potato, spinach, sweet corn and rutabaga.

❖ TREATMENT

Cultural control: A hard spray of water directed at the infested shoots can wash away the aphids.

Chemical control: Spray or dust when aphids are abundant. Not all recommended pesticides are registered for all vegetables; read product label carefully.

Recommended products: diazinon, dimethoate, insecticidal soap, malathion, pyrethrins

BACTERIAL SOFT ROT

Bacterial soft rot attacks many vegetables in field and storage, including bok choy, carrots, Chinese cabbage, Spanish onion, sweet potato, garlic, lettuce, cucumber, melon, pepper and tomato. Bacteria enter through wounds causing a rapid, wet rot with an offensive odour. Flesh becomes very soft and pulpy.

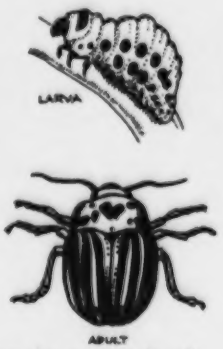
❖ TREATMENT

Cultural control: Avoid wounding vegetables during cultivation and harvest to minimize sites of infection. Store only vegetables without wounds.

Chemical control: None

COLORADO POTATO BEETLES and BLISTER BEETLES

see Plates 2 & 3



Colorado potato beetles, which attack potato, eggplant, pepper and tomato, are striped yellow and black and about 10 mm long. The larvae or grubs are brick red with rows of black dots. They cause more damage than the adults do, feeding voraciously on the leaves and, when present in sufficient numbers, they reduce yield significantly. The eggs are orange and are laid on the underside of the leaf. Blister beetles may cause more damage in northern Ontario than Colorado potato beetles but treatment is the same.

❖ TREATMENT

Cultural control: Hand pick beetles and grubs and kill them in a pail of soapy water. Crush the eggs when observed. Eggplants, because of their large leaves and vigorous growth, may be used as a trap crop, luring the beetles and withstanding their attack. Pick the trap plants frequently.

An alternative method to control Colorado potato beetles and blister beetles without pesticides, is to plant early or medium-early varieties of potatoes. Presprout seed potatoes in trays under light during April and plant in early May. An acceptable crop can be harvested by mid-July, before insects have completely destroyed the foliage, stopping any further growth of the tubers.

Chemical control: There is resistance to many pesticides so hand picking is recommended. Apply insecticide when injury is seen and repeat the application as needed.

Recommended products: carbaryl, diazinon, dimethoate, malathion, methoxychlor, permethrin, pyrethrins, rotenone

* Only available in multipurpose mixtures

** See "Resistance to benomyl", pg. 25

*** Wash vegetables treated with maneb before eating. Discard water used for boiling.

CUTWORMS

see Plates 4 & 5

Cutworms are greyish caterpillars that lie in a curled position just below the soil surface by day and feed at night. They cut young plants off at ground level. Cutworms are most active during May and June. Some are climbers, such as the variegated cutworm, which appear later in the growing season.

❖ TREATMENT

Cultural control: Plants can be protected by lightly pushing cylinders, made from tar paper or empty cans (bottom removed) into the soil around each plant. This method is practical for cabbage, tomato and similar crops but not for peas, beans and other closely seeded vegetables. When chewed-off plants are found, scratch the soil to find and remove the worm to avoid losing other plants.

Chemical control: Four methods of control are available. Read the product label for the crops on which these insecticides may be used.

1. To prevent cutworm damage, apply insecticide to soil before planting and mix to a depth of 5 cm.
   Recommended product: chlorpyrifos (dust or granular), diazinon (spray), permethrin
2. If damage to growing plants is noticed, spray or dust plants and soil around stem.
   Recommended product: carbaryl, chlorpyrifos (spray), permethrin
3. To kill climbing cutworms, thoroughly spray the plant and nearby soil when damage is seen.
   Recommended product: carbaryl, permethrin
4. Scatter bait pellets along the row or place pellets at the base of each plant.
   Recommended product: carbaryl (bait)

DAMPING-OFF

Damping-off disease is caused by various fungi. Affected seedlings rot or collapse soon after emergence, particularly in greenhouses or cold frames. The disease rarely attacks all plants in a flat, but rather patches or part rows. Excessive soil moisture, dense seeding, and cool soil temperature promote its development.

Damping-off in seedlings

Damping-off. Notice the constriction at the stem base

❖ TREATMENT

Cultural control: Sow seed thinly and thin crowded seedlings. Water only when necessary with tempered water early in the day. Ventilate cold frames or greenhouse regularly. Maintain moderate media and air temperatures (20 to 22°C). Use only sterilized soil, tools and flats to prevent its likelihood of appearing.

Chemical control: If using unpasteurized soil, drench soil surface with preventive fungicide before seeding or transplanting, according to label directions. This chemical may be applied on seedling plants when the disease develops, but controls only some of the damping-off fungi.

Recommended product: oxine benzoate

EARWIGS

Earwigs are reddish-brown, 2 cm long and have a pair of forceps-like appendages at hind end. They are active at night and hide by day in soil, under stones or debris and on underside of leafy vegetables. They feed on seedling carrots, beans and beets. They are also good climbers, and can be found under husks of sweet corn.

❖ TREATMENT

Cultural control: Place wooden board traps or damp burlap in garden each evening. Collect the

traps each morning and destroy the earwigs.

Chemical control: When many earwigs are found, spray or dust the soil, or scatter bait pellets around plants, preferably in June or early July.

Recommended products: carbaryl, chlorpyrifos (dust)

FLEA BEETLES

see Plate 6

Flea beetles are small black or brown insects about 2 mm long. They are very active pests, and early in season, can eat many small, round holes in the leaves of potato, tomato, pepper, eggplant, cabbage, cauliflower, broccoli, oriental vegetables, Brussels sprouts, radish, rutabaga and corn. Plants are usually not killed, but growth is delayed.

❖ TREATMENT

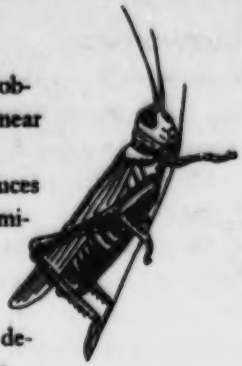
Cultural control: Late or delayed seeding may help reduce infestation. Cover young plants with polyester row covers, which are white hoop-shaped fabric tents (see pg. 41).

Chemical control: Treat only if damage is severe. Not all recommended pesticides are registered on all vegetables; apply only on crops listed on the label.

Recommended products: carbaryl, chlorpyrifos (on potato only), diazinon, methoxychlor, permethrin, (on cabbage, cauliflower, broccoli, Brussels sprouts only), pyrethrins, rotenone

Flea beetle injury on potato leaves: note shot-holes in leaf.

GRASSHOPPERS



Grasshoppers may become a problem with a lush garden located near weedy areas, abandoned fields, woodlots, etc. Dry weather reduces normal food and grasshoppers migrate into the garden.

❖ TREATMENT

Cultural control: Catch and destroy invading grasshoppers.

Chemical control: Young grasshoppers are much more susceptible to insecticides than adults are.

Recommended product: malathion

MILLIPEDES

Millipede in coiled position.

Millipedes are dark brown worms 3 cm long with about 100 legs. They are usually found hiding or coiled up like a spring. They feed on manure and decaying organic matter and do little or no harm to plants. They should not be controlled. The millipede is often mistaken for a wireworm (see pg. 53) which is orange with six pairs of legs and can cause severe damage to plants.

SLUGS and SNAILS

Slugs and snails hide by day in dark, moist places and feed by night on the leaves of plants. A sticky, viscous trail across leaves and soil is evidence of snails and slugs. Mulch aggravates the problem. Slugs cause more damage than snails but control is the same.

❖ TREATMENT

Cultural control: Remove materials from the garden which provide daytime hiding sites such as plant debris, rocks, boards and logs. Thin or space densely growing plants. Place shallow dishes of beer or juice as bait in garden; replace frequently. Set out traps of 15 cm square boards and hand

* Only available in multipurpose mixtures

** See "Resistance to benomyl", pg. 25

*** Wash vegetables treated with rotenone before eating. Discard water used for boiling.

pick slugs and snails from under the boards in the morning.

Chemical control: When injury is noticed, place bait in spoonfuls on soil at about 1 m intervals; cover bait with boards or bricks. Moist bait attracts slugs; if soil is dry, water lightly. Do not apply bait on edible parts of vegetables.

Recommended product: metaldehyde

Caution: Bait is attractive and very poisonous to dogs and birds.

SOWBUGS and PILLBUGS

Sowbugs and pillbugs have flat, oval, grey-brown 1 cm long bodies with seven pairs of legs. They are found in damp places, under garden debris and litter. They seldom harm plants and are beneficial because they break down organic matter. Normally they do not need to be controlled. However, they may cause damage to young plants by feeding on leaves at night.

❖ TREATMENT

Cultural control: Follow garden sanitation practices.

Chemical control: Bait may be used.

Recommended product: carbaryl (bait)

TARNISHED PLANT BUGS

see Plate 7

Tarnished plant bugs feed on many vegetables including bean, celery, eggplant, lettuce, broccoli, cauliflower, pepper, potato and tomato. They are present throughout the growing season, injecting toxic saliva into the plants causing spotting and decay of flowers, shoot tips and fruit, thus allowing diseases to enter through the wounds.

Adult tarnished plant bugs (TPB) are brown, while the four-lined plant bugs (FLPB) are greenish-yellow with four black stripes. Both are triangular in front, 6-7 mm long and about half as wide. They are very active, readily flying when disturbed. TPB larvae are light green, while young FLPB are bright red, each with dark spots and markings. TPB can be a problem throughout the season, while FLPB is prevalent in late spring and summer. The adults overwinter in crop litter and breed in woody hosts.

❖ TREATMENT

Cultural control: Follow garden sanitation procedures.

Chemical Control: Apply insecticide when young are first noticed in the spring.

Recommended products: carbaryl, malathion, permethrin

VIRAL DISEASES

Viral diseases cause malformation and growth distortions of leaves, flowers and fruit. Insects, particularly aphids, spread most viruses.

Cucumber mosaic virus causes leaves to be mottled yellow and green on crops in the cucurbit family as well as tomato, pepper, spinach, celery, beans, peas, potato, rhubarb and others. Fruits may be bumpy, malformed and coloured with a yellow and green mosaic pattern.

Tobacco mosaic virus (TMV) causes leaves of tomatoes, peppers and other crops to be malformed, mottled, or patchy. Vines may be dwarfed, bearing fewer and smaller fruits.

❖ TREATMENT

Cultural control: Plant resistant varieties. Control aphids, as they are the main spreaders of disease. Sanitize tools and wash hands after handling infected plants, as viruses can also be spread by contact with infected sap.

Chemical control: None

WHITE GRUBS and WIREWORMS

see Plate 8

White grubs are young June or Japanese beetles, or European chafers. They are plump, white larvae with brown heads. Wireworms are orange, hard-bodied larvae with six legs. Both insects eat roots.

❖ TREATMENT

Cultural control: White grubs and wireworms live in sod. Dig or till sod for new gardens before mid-May and do not grow vegetables until the following year. This exposes the grubs and wireworms to the air, thereby killing them. It also

allows sod to decompose and aids weed control. If land in sod must be used immediately for vegetables, delay as long as possible and rototill the site thoroughly before planting.

Wireworms

Chemical control: None

WHITE MOULD

White mould affects all vegetables except corn, but is usually first found on bush beans during wet weather or repeated watering, spreading quickly under wet conditions. Leaves, stems and pods turn brown and rot, developing masses of mycelium that appear as white cotton-like tufts containing round, black resting spores called sclerotia. The sclerotia overwinter in diseased plants left in garden, compost pile or soil.

❖ TREATMENT

Cultural control: Select plant varieties that are resistant to white mould. Pull out and remove affected plants as well as fallen leaves as soon as first observed. Do not work into soil or compost. Follow garden sanitation and watering procedures and widely space plants when seeding.

Chemical control: None

White mould on beans; healthy pods are on right

WILT DISEASES

see Plate 9

Wilt diseases caused by the soil-dwelling fungi Verticillium and Fusarium are usually first seen in hot, dry weather. These fungi attack plant roots, growing inside and preventing the flow of water and nutrients into the above ground parts of the plant. Because of the restrictions, plants wilt and produce a poor crop, or die completely. Brown discoloration can be seen in the water-conducting vessels of the plant when the stem is cut.

Some bacteria also cause wilt diseases, such as the bacterial wilt of cucumbers and melons caused by infested cucumber beetles feeding on cucumber and melon plants.

❖ TREATMENT

Cultural control: Select plant varieties that are resistant to wilt. Dig out and remove all parts of affected plants. For control of cucumber beetles to prevent bacterial wilt of cucumbers and melons see pg. 61. If Verticillium fungus is suspected, do not plant strawberries, raspberries, or vegetables in the potato family (tomato, potato, eggplant, pepper) in that location for several years. It is very difficult to distinguish between Verticillium and Fusarium based on visual symptoms alone; however, a soil sample or plant sample may be sent to the Pest Diagnostic Clinic for positive identification (see pg. A-1).

Asparagus

ASPARAGUS BEETLES

Asparagus beetles occasionally damage both the spear and the fern stages of plant growth. There are two species of beetles, one orange with black spots, the other metallic blue-black with 6 yellow spots; both are about 0.5 cm long. Larvae are olive-green or dark grey, emerging from dark, bullet-shaped eggs, which are very visible on the developing spears in late May, early June.

❖ TREATMENT

Cultural control: On small plantings, hand pick and destroy beetles. Cut and destroy any spears when eggs are observed. Destroy nearby wild asparagus, which could harbour beetles.

Chemical control: When beetles or larvae are numerous or damage is noticed, spray or dust after

harvest. Spray new plantings not being harvested when beetles appear.

Recommended product: carbaryl, malathion, pyrethrins, rotenone

ASPARAGUS RUST

Asparagus rust appears in the late spring as slightly raised, light green, oval lesions. They turn creamy-orange and then reddish-brown and blister as they mature. Severe rust infections stunt growth, reduce plant vigour and may even kill young shoots.

❖ TREATMENT

Cultural control: Plant tolerant varieties. Remove infested crop residues. Cut spears below the soil line during harvest.

Chemical Control: Apply as directed on label.

Recommended product: zineb

Beans *(not Broad, Fava or Windsor)*

BEAN RUST

Bean rust can be a very devastating disease that re-occurs yearly if not controlled. Numerous reddish-brown, circular, raised lesions up to 2 mm in diameter appear on leaves and sometimes pods. If leaves are severely infected, they will shrivel and drop. Infection is favoured in moderate temperatures when plants are moist for 10-18 hours. Pole beans are more susceptible than bush beans.

❖ TREATMENT

Cultural control: Plant resistant varieties. Rotate crops. Remove all infected plant residues. Follow proper watering practices and promote air circulation. In a small garden it may be necessary to stop growing beans for at least one growing season.

Chemical control: None

LEAFHOPPERS

Leafhoppers suck sap from the underside of leaves, leaving them stunted, crinkled and rolled upwards. The insects are about 3 mm long, pale green, and move quickly when the plant is touched, making them difficult to see.

❖ TREATMENT

Cultural control: None

Chemical control: Check undersides of leaves and treat as soon as insects or plant injury is noticed.

Recommended products: carbaryl, diazinon, dimethoate, malathion, methoxychlor, pyrethrins

MEXICAN BEAN BEETLE

The Mexican bean beetle is a dirty to coppery-yellow colour with 16 black dots (8 on each wing cover). It belongs to the same family as the ladybug and may be mistaken for it. The Mexican bean beetle overwinters in garden debris and appears on beans in late June. Later, groups of orange-yellow eggs will be seen on the underside of bean leaves. Soft, yellow larvae, 2mm long with black-tipped spines develop from the eggs. They feed on the underside of leaves, removing the green and leaving the veins. They are seldom a problem except in the Niagara peninsula, and along Lakes Erie, St. Clair and southern Lake Huron.

❖ TREATMENT

Cultural control: Do not mistakenly kill the beneficial ladybugs. Hand pick and destroy adults and larvae. Crush egg masses when observed. Follow garden sanitation procedures, especially in the fall to prevent beetles overwintering in plant debris.

Chemical control: Spray or dust when first seen. Do not mistakenly kill the beneficial ladybugs.

Recommended products: carbaryl, dimethoate, malathion, methoxychlor, pyrethrins

SEED-CORN MAGGOTS

Seed-corn maggots attack the seed, preventing germination, or the germ of emerging seedlings. Adult flies lay their eggs in May

* Only available in multipurpose mixtures

** See "Resistance to Insects", pg. 25

*** Wash vegetables treated with insecticides before eating. Discard water used for boiling.

in recently manured soil and rotting vegetation.

❖ **TREATMENT**

Cultural control: Spread manure and till soil in fall. Seed shallowly to promote quick germination. Sow crops after June 1 in southern Ontario and June 10 in northern areas. This insect is not a problem everywhere; be guided by local experience in previous years.

Chemical control: None

WHITE MOULD

White mould can affect all vegetables except corn but is usually first found on bush beans during wet weather or repeated watering. Leaves, stems and pods brown and rot; white cotton-like tufts of mycelium and round, black resting spores develop within the mycelium. The disease spreads quickly in wet conditions, and the fungus overwinters in diseased plant residue left in garden, compost pile or soil.

❖ **TREATMENT**

Cultural control: Plant resistant varieties. Dig out and remove affected plants as well as fallen leaves. Do not work into soil or compost. Follow garden sanitation and watering procedures and widely space plants when seeding.

Chemical control: None

Beans: *Broad, Fava or Windsor*

APHIDS

These beans are different from green and wax beans. They are not attacked by the same insects, but are often severely infested by aphids (see pg. 50), which can lead to mosaic and yellow mosaic virus.

❖ **TREATMENT**

Cultural Control: Plant broad beans as early as possible, or start them indoors and set out as transplants to avoid heavy aphid infestations.

Chemical Control: See Aphids, pg. 50.

Beet, Swiss Chard, Spinach

LEAFMINERS

Leafminers cause blister-like blotches on leaves. Normally, no control is required if only roots and stems are eaten. Control may be necessary on spinach and Swiss chard.

❖ **TREATMENT**

Cultural control: Grow New Zealand-type spinach, which is not attacked. Discard damaged leaves in the garbage; do not compost.

Chemical control: Apply insecticide when first blotches are noticed if this is an annual problem.

Recommended products: diazinon, malathion

Leafminer injury on spinach.

Broccoli, Brussels Sprouts, Cabbage, Chinese Cabbage, Kale, Kohlrabi, Radish, Rutabaga

ALTERNARIA LEAF SPOT

Alternaria leaf spot is a fungal disease that occurs on leaves. Spots are brown and target-like with concentric rings, and develop felt-like dark brown mould in wet weather. The fungus can be seed-borne, or survive in infected crop residue for up to two years.

❖ **TREATMENT**

Cultural control: Follow proper watering and sani-

tation procedures. Purchase hot-water treated seed.

Chemical control: Fungicide sprays should begin in late summer when periods of wet weather are more frequent.

Recommended products: chlorothalonil

BACTERIAL BLACK ROT

Plants may become infected from seedling stage to harvest and in storage. A wilted, often-yellowish V-shape appears on cabbage leaf margins. Veins may be black or dark brown. They can be seen in stalks and stems of rutabaga and turnip and roots of kohlrabi, showing as a black ring or arc if cut crosswise. The bacteria overwinter on or in the seed and in plant refuse and spread on dirty tools and by splashing water.

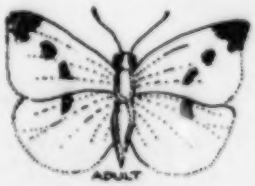
❖ TREATMENT

Cultural control: Buy transplants from a reliable retailer or hot-water treated seed. If black rot is found, collect plant remains and eliminate them.

Chemical control: None

CABBAGEWORMS *see Plate 10*

Cabbageworms are a common, annual problem throughout Ontario. They are pale green caterpillars, difficult to see, up to 30 mm in length, with a faint orange stripe. They often lie along the midrib of the leaf. White butterflies are a warning that eggs are being laid.



❖ TREATMENT

Cultural control: Inspect plants frequently. Hand pick and destroy caterpillars when seen.

Chemical control: Treat when worms or holes in leaves are noticed and repeat throughout the summer as needed.

Recommended products: Bacillus thuringiensis, carbaryl, diazinon, malathion, methoxychlor, permethrin, rotenone

CABBAGE LOOPERS *see Plate 11*

Cabbage loopers, 4 cm long when mature, are pale green caterpillars with white stripes along back and sides. Their looping movement easily identifies them. They feed on leaves and can cause severe damage.

❖ TREATMENT

Cultural control: Hand pick and destroy caterpillars when seen.

Chemical control: Mature looper caterpillars are very difficult to kill. Spray or dust when they are small and repeat at seven-day intervals as needed.

Recommended products: Bacillus thuringiensis, carbaryl, permethrin, pyrethrins

CLUBROOT *see Plate 12*

Clubroot is a very serious disease caused by a soil-borne fungus, which will remain in soil indefinitely. Roots develop club-like swellings and when severe, the entire root system is deformed. Garden soil can become infested by purchasing transplants or soil from infested fields. Infested soil clinging to tools and equipment can also spread disease. Acid soils favour development of the fungus. Cruciferous weeds, such as those in the mustard family, yellow cress, stinkweed, pepper grass and shepherd's purse, are also attacked, and maintain the fungus in the soil.

❖ TREATMENT

Cultural control: Dig out all affected roots at harvest and discard them. Do this even if soil was infected before planting. Discard whole flat or box if any affected seedlings are found. As much as possible, eliminate cruciferous weeds in your garden. Incorporate agricultural lime into the soil to raise the pH to about 7.2. Hydrated lime (available at a building supply) will change the pH more quickly; use at the rate of 1 kg per 6 m^2 and dig or rototill into soil about three weeks before planting. Have your soil tested to know the pH level.

Chemical control: None

DIAMONDBACK MOTHS *see Plate 13*

Diamondback moth larvae are 1 cm green caterpillars. When disturbed they often wriggle quickly backwards or drop off the plant on a silken thread. They eat small holes in the leaves with part of the leaf tissue

* Only available in multipurpose mixtures

** See "Resistance to Insecticides", pp. 25

*** Wash vegetables treated with cresols before eating. Discard water used for boiling.

still covering the hole. Their movement and eating patterns distinguish them from cabbageworms.

❖ **TREATMENT**

Cultural control: Hand pick and destroy caterpillars.

Chemical control: Spray or dust and repeat at seven-day intervals as needed.

Recommended products: Bacillus thuringiensis, carbaryl, permethrin, pyrethrins

DOWNY MILDEW

Downy mildew is a fungus, which primarily occurs in cool, moist weather in spring and fall. Yellow patches develop on leaves, later becoming brown and faintly netted with dark markings. Underside of patches may be covered with a downy, white fungus under humid conditions.

❖ **TREATMENT**

Cultural control: Plant resistant varieties.

Chemical control: If observed, spray in anticipation of cool, moist weather.

Recommended products: chlorothalonil, copper

MOSAIC VIRUS

Mosaic virus causes a long, crooked neck and a small, slender root on rutabagas and turnips. In late summer, cabbage, cauliflower and broccoli may also be affected, resulting in a continuous dropping of lower leaves, which leads to long bare stems and poorly developed heads.

The mosaic virus is spread by aphids.

❖ **TREATMENT**

Cultural control: Plant early to minimize transmission by aphids

Chemical control: See pg. 50 for control of aphids.

ROOT MAGGOTS

see Plate 14

Root maggots cause severe damage to young plants every year.

There are three generations of the adult fly which lay their eggs in soil near plants in May, early July and mid-August. The first generation causes the most damage. White maggots feed on roots, creating entry sites for rot. Plants become stunted and turn blue-grey; edges of leaves curl. Young plants are usually killed. Older plants survive, but growth is reduced.

❖ **TREATMENT**

Cultural control: With rutabaga, avoid first-generation maggots by delaying sowing until early July (mid-June in Northern Ontario). Injury by the second and third generation maggots can be trimmed off before cooking.

Sow seed in a frame tightly covered with mosquito screen or cheesecloth to prevent maggot flies from laying eggs near the seedlings. Make a collar from a 10 cm x 10 cm piece of tarpaper or stiff plastic with small a hole cut in the centre and slit down one side to slide over the stem of each plant when transplanting into the garden. The collar must lie flat on smooth soil; it is helpful to place a small stone on the cut.

Chemical control: If cultural methods are not followed, apply insecticide in seed furrow or around transplants before or at seeding, or immediately after transplanting.

Recommended product: diazinon (granular)

Carrot, Celery, Lettuce, Parsnip

ASTER YELLOWS

see Plate 15

Aster Yellows is caused by a mycoplasma-like organism, with symptoms similar to viral diseases. It affects carrot, celery and lettuce, turning leaves yellow and stunting growth. Carrots also develop multiple crowns and many lateral roots. The disease is spread by the six-spotted leafhopper.

❖ **TREATMENT**

Cultural control: Prompt removal and destruction of affected plants is of some help.

Chemical control: Chemical control aims to check the spread of the leafhopper insect, but success is limited because there is no highly effective insecticide and because the timing of the applications are critical.

CARROT RUST FLIES

The first generation adults of carrot rust flies lay eggs near the young carrot and parsnip plants during May; the small yellowish-white maggots that hatch invade the roots. A second generation usually occurs in mid-to-late July. Roots are covered with rust-red burrows and surface scars.

Injury by carrot rust fly maggot

❖ **TREATMENT**

Cultural control: Delay seeding until July 1. This usually reduces populations of the second generation in late July, but some damage by the larvae may be expected. Plant these crops away from sheltered areas as this fly avoids windy locations.

Chemical control: If maggots are known to be a problem, apply insecticide in the seed furrow before or at seeding; pesticides cannot kill maggots when mature. Reapply spray to soil when second generation lays eggs in late July if necessary.

Recommended product: diazinon (granular or spray)

DOWNY MILDEW

Downy mildew is a fungal disease that affects lettuce and primarily occurs in cool, moist weather in spring and fall. Yellow patches develop on leaves, later becoming brown and faintly netted with dark markings. Underside of patches may be covered with a downy, white fungus growth under humid conditions.

❖ **TREATMENT**

Cultural control: Plant resistant varieties, space adequately and follow proper watering practices.

Chemical control: Spray as required.

Recommended product: maneb***

LEAF SPOTS and BLIGHT

Leaf spots and blight are quite common on carrot and celery and cause leaves to turn brown or black and curl. First symptoms appear on the lower leaves, usually in late July. On carrots, mild symptoms do not need to be treated. On celery, usually older, outer leaves are affected, making treatment unnecessary unless the blight starts to affect the celery stalks or when a majority of the leaves are infected.

❖ **TREATMENT**

Cultural control: Plant disease-free, hot-water treated seed. Follow proper watering procedures. Rotate crops and improve air circulation.

Chemical control: Spray or dust three times at seven-day intervals.

Recommended products: chlorothalonil, copper, maneb***

Corn (Sweet)

When treating sweet corn pests, carbaryl is a common chemical treatment. Remember, however, that carbaryl and other insecticides will poison honeybees collecting pollen from leaves and tassels. See discussion on pg. 23.

CORN EARWORMS

In some years, the tips of corn ears can be infested with robust caterpillars with brown, green and yellow striped bodies. It is very difficult to predict when or if infestations will occur. However, the moths generally migrate from the south and do not arrive before August, so early sweet corn will not be affected.

❖ **TREATMENT**

Cultural control: Cut ear tips off corn before cooking.

Chemical control: Control is usually not necessary except in south-western areas of Ontario where

* Only available in multipurpose mixtures

** See "Resistance to benomyl", pg. 25

*** Wash vegetables treated with maneb before eating. Discard water used for boiling.

earworms have been a problem. Apply four times at four-day intervals (three-day intervals during hot weather), beginning when 25% of ears show silk.

Recommended products: carbaryl, permethrin

CORN ROOTWORMS

Two types of beetles, one pale green, the other yellow with black stripes, each about 6 mm long, feed on corn silks and pollen. There is only one generation per year. The beetles emerge about the first week of August and the females lay clusters of eggs up to 5 cm deep in the soil at the base of corn plants. The larvae tunnel into corn roots and feed heavily, causing plants to break as corn matures; they then emerge and burrow into the crown of the corn stalk and remain in the residue until next spring. If silk is eaten before pollination takes place, the ear will not fill properly. This is a particular problem on late-maturing corn.

❖ TREATMENT

Cultural control: Rotate crop so that it is planted at a distance from last year's to prevent damage from larvae. Adult beetles are difficult to control on corn silks, except by covering the silks with screen caps.

Chemical control: Apply as directed on label.

Recommended product: carbaryl (Sanex Liquid Sevin)

CORN SMUT GALLS

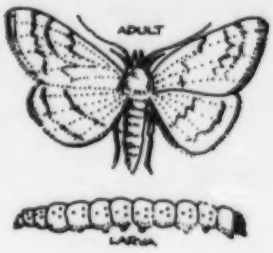
Corn smut galls may appear on any visible part of the corn plant. A thin silvery-grey membrane appears, forming a gall that breaks open to release black spores. Spores are carried by the wind and may survive in soil or plant remains for several years, reproducing and carrying infection from cornfields in the vicinity.

❖ TREATMENT

Cultural control: Destroy smut galls before they burst open. Plant resistant varieties.

Chemical control: None

EUROPEAN CORN BORERS *see Plates 16 & 17*



European corn borer larvae are a dirty-white or pinkish colour with brown dots and about 2.5 cm long when full grown. Masses of eggs, resembling fish scales, are laid on underside of leaves near midrib. Larvae feed on leaves, making small holes, then bore into the stalks causing breakage, and feed on cobs and kernels. There are two strains of this insect in Ontario, one having two generations per year, the other only one.

The two-generation strain occurs in the area south of a line between Simcoe, London, and Sarnia. Its eggs are laid on corn between early June and early July, and again from late July to early September. The one generation strain occurs throughout Ontario, laying its eggs from late June to mid-August. Both strains may be present in the same area at the same time.

❖ TREATMENT

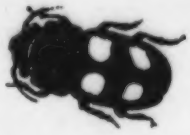
Cultural control: Treatment is not required if some cob damage is tolerable. Cut out infested areas on cobs before consumption.

Chemical control: Two-generation area: When corn is about 30 cm tall, or when egg masses are observed on leaves, spray or dust into the whorl, a group of leaves which have a tubular appearance before the tassel emerges from the top, twice at 5-7 day intervals. Spraying must not begin later than when pinhole-sized feeding damage is observed on young leaves or larvae will already be safe from insecticide inside the plant. The second generation is very difficult to control, and usually occurs on late-planted corn. Make four applications at five-day intervals when egg masses or first feeding injury is observed. Later sprays, after tassels appear, should be directed at the ear.

One-generation area: Insecticide applications must begin before tassels begin to appear and when egg masses are observed. Make initial application in whorl, followed by two later sprays at 5-7 day intervals. Aim sprays at the ear after tassels appear.

Recommended product: carbaryl

SAP BEETLES



Small black beetles with four cream-coloured markings sometimes infest corn ears, especially those with previous insect or bird injury, or which have loose fitting or previously opened husks.

❖ **TREATMENT**

Cultural control: Avoid damaging developing ears. Use overripe melon halves as bait in the garden. Control corn borers to reduce sap beetle populations.

Chemical control: Use bait as directed on label.

Recommended product: carbaryl (bait)

SEED-CORN MAGGOTS

Seed-corn maggots are dirty-coloured yellowish-white larvae about 8-10 mm long that burrow into the seed where they can be found under the seed coat. The seed usually fails to germinate or sprout, or growth is weak and spindly. The adult flies lay their eggs in May, favoured by wet soil conditions, recently manured soil or a cold spring. Corn, squash, cucumber, radish, beans, peas, and beets are affected.

❖ **TREATMENT**

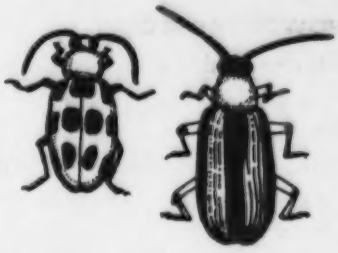
Cultural control: If there is a history of damage in the area, grow transplants in containers indoors or in a frame covered tightly with mosquito screening or cheesecloth. Transplant at any time.

Chemical control: None

Cucumber, Melon, Pumpkin, Squash, Zucchini

Plants are pollinated by bees and some insecticides in multipurpose mixtures may be very harmful to them. Rotenone is the safest pesticide for bees. (See Pesticides, pg. 23).

CUCUMBER BEETLES



Cucumber beetles are a common problem. They are striped yellow and black or yellow with black dots and are about 6 mm long. They move quickly when disturbed. Young plants are killed by defoliation and older plants wilt and die from bacterial disease carried by beetles.

❖ **TREATMENT**

Cultural control: None

Chemical control: Treat when beetles are first noticed.

Recommended products: malathion, methoxychlor, rotenone

CUCUMBER SCAB

Cucumber scab symptoms appear as grey, sunken spots on the fruit, darkening and sinking with age, sometimes exuding a gummy substance. Most of the injury occurs on the fruit but leaves may have water-soaked spots and stems may have cankers. Cooler night temperatures from mid-summer on favour this disease.

❖ **TREATMENT**

Cultural control: Clean up all plant residues in fall. Plant resistant cultivars or consider a long crop rotation.

Chemical control: None

LEAF SPOTS

Small, circular, grey to black, spots appear on the leaves, often with a yellow halo. The leaves drop from the vines causing reduction in crop yield and quality.

Treatment

Cultural control: Plant resistant varieties. Remove infected leaves to eliminate plant residue for disease to overwinter. Do not compost.

Chemical control: Spray or dust as soon as noticed and repeat every 5 to 7 days as needed.

Recommended products: carbaryl, chlorothalonil, copper (spray preferred), maneb***

* Only available in multipurpose mixtures

** See "Resistance to benomyl", pg. 25

*** Wash vegetables treated with maneb before eating. Discard water used for boiling.

POWDERY MILDEW

Powdery mildew appears as a dry talcum powder-like mass of white spores on upper leaf surfaces during hot, humid days and cool nights, resulting in the death of the leaf tissue. When severe, mildew significantly reduces crop yield and causes the plant to die prematurely.

Powdery mildew

❖ **TREATMENT**

Cultural control: Plant resistant varieties.

Chemical control: Spray when disease is first noticed, preferably as a preventive measure.

Recommended products: benomyl**, chlorothalonil, folpet

SEED-CORN MAGGOTS

Seed-corn maggots are dirty-coloured yellowish-white larvae about 8-10 mm long that burrow into the seed where they can be found under the seed coat. The seed usually fails to germinate or sprout, or growth is weak and spindly. The adult flies lay their eggs in May, and attack is favoured by wet soil conditions, recently manured soil or a cold spring.

❖ **TREATMENT**

Cultural control: If there is a history of damage in the area, grow transplants in containers indoors or in a frame covered tightly with mosquito screening or cheesecloth. Transplant at any time after the soil has become warm.

Chemical control: None

SQUASH BUGS

Squash bugs are sap-sucking insects affecting mainly pumpkin and squash, but sometimes cucumber and melon. Young bugs, or nymphs, are grey; adults are dark brown and about 17 mm long. Affected areas of leaves, stems and vines are lighter in colour at first and later turn brown and die.

❖ **TREATMENT**

Cultural control: In June, place traps of boards and stones between plants and remove bugs from under them each morning. Follow good garden sanitation practices in the fall.

Chemical control: Treat when injury or bugs are first noticed; repeat as needed.

Recommended products: carbaryl, methoxychlor, rotenone

SQUASH VINE BORERS

Squash vine borer adult moths, which have metallic olive-brown wings and an abdomen ringed with red and black, lay large reddish-brown eggs on stem near the soil in late June through late July. They hatch into creamy white, brown-headed insects, enter and feed inside vine stems for four to six weeks. Coarse greenish-yellow excrement, pushed out by the borer through holes, can be seen along the sides of the stem. Plants wilt suddenly and may break or rot from the point of attack. Fruit is poor and small. The insect overwinters in the soil and once it is in a garden, the problem occurs every year.

❖ **TREATMENT**

Cultural control: Destroy eggs before they hatch. When vines wilt and the holes of the borer are noticed, slit stem lengthwise and remove borer. Mound soil over injured area and over vines near leaves to promote new root growth from stems. The Butternut variety is resistant to the squash vine borer.

Chemical control: Preventive spraying or dusting of the base of the vines is necessary. Make applications at weekly intervals starting in late June.

Recommended product: rotenone

Kohlrabi

See Broccoli, pg. 56.

Leek

See Onion, pg. 63.

Lettuce

See Carrot, pg. 58.

Melon

See Cucumber, pg. 61.

Onion, Leek

DOWNY MILDEW, PURPLE BLOTCH, BOTRYTIS LEAF BLIGHT *see Plates 18, 19, 20*

Downy mildew, purple blotch and Botrytis leaf blight are common fungal diseases, causing leaf spotting and discolouration, particularly on Egyptian tree onions, onions grown from sets, Spanish onions and multiplier bulbs. The diseases favour wet conditions.

❖ **TREATMENT**

Cultural control: Destroy diseased onion leaves and discarded bulbs at harvest time. Dry cooking onions properly for winter storage to discourage bulb rot.

Chemical control: Treat as soon as first injury is noticed and repeat at seven-day intervals.

Recommended product: maneb***

ONION MAGGOTS

Onion maggots can cause severe damage every year in some areas but not in others. Be guided by local experience. In May, the first-generation flies lay their eggs near onion plants, seldom near leeks. The white maggots attack the lower stem of the plant soon afterwards and tunnel inside, killing many plants. Yellowing of leaves is usually the first sign of a problem, and indicates that maggots are feeding on the roots. Maggots from second generation flies cause less damage during late July and early August and plants are seldom killed. The last generation eggs hatch in mid-September.

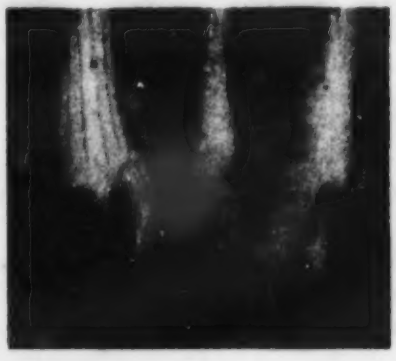
❖ **TREATMENT**

Cultural control: Plant onion sets (small, dormant bulb) after June 1 to escape most first-generation maggots. Do not sow seeds at this time, as it is too late. Buy sets early and store them in a refrigerator to keep them in good condition until planting time. If all affected onions are collected and destroyed, there will be very few maggots to overwinter. Follow proper garden sanitation procedures.

Chemical control: Apply diazinon in the furrow at the time of planting or sowing if sowing early.

Recommended product: diazinon (granular)

Onion maggot and injury



THRIPS *see Plate 21*

Thrips cause stippling or streaking on leaves. The small insects are seldom observed but can be found in the centre of the plant or in the folds of the leaf. Spanish onions and green onions are particularly susceptible. On Spanish onions, severe thrips injury

* *Only available in multipurpose mixtures*

** See "Resistance to benomyl", pg. 25

*** Wash vegetables treated with maneb before eating. Discard water used for boiling.

promotes secondary bacterial rots.

❖ **TREATMENT**

Cultural control: Watering will help reduce thrips populations Follow garden sanitation procedures.

Chemical control: Treat when injury is noticed, and repeat as needed. For leeks use only malathion.

Recommended products: diazinon, malathion

Parsnip

See Carrot, pg. 58.

Potato

Always plant certified seed potatoes or home-grown potatoes produced from healthy plants to avoid bringing diseases into the garden, which remain in the soil and infect plants for years.

Do not use table potatoes purchased from the supermarket. They are often treated to prevent sprouting and will not develop into good plants.

ANTHRACNOSE

Anthracnose fungi persist in soil and crop residue and start below the soil surface on potato, causing brown dead areas along, and sometimes completely girdling, the stem. The tubers are infected causing black dots in the outer skin of potato and inside hollow stems.

❖ **TREATMENT**

Cultural control: Rotate crops. Clean up plant residue when digging potatoes to prevent overwintering of spores.

Chemical control: Apply fungicide sprays as directed on label.

Recommended products: chlorothalonil, copper

COLORADO POTATO BEETLES and BLISTER BEETLES

see Plates 2 & 3

Colorado potato beetles, which attack potato, eggplant, pepper and tomato, are striped yellow and black and about 10 mm long. The larvae, or grubs, are brick red with rows of black dots and cause more damage than the adults, feeding voraciously on the leaves and, when present in sufficient numbers, reducing yield significantly. Eggs are orange and are laid on underside of leaf. Blister beetles cause more damage in northern Ontario than do the Colorado potato beetles.

❖ **TREATMENT**

Cultural control: Hand pick beetles and grubs and kill them in a pail of soapy water. Crush eggs when observed. Eggplants, because of their large leaves and vigorous growth, may be used as a trap crop, luring the beetles and withstanding their attack. Pick the trap plants frequently.

There is resistance to many pesticides so hand picking is recommended.

An alternative method to control Colorado potato beetles and blister beetles without pesticides is to plant early or medium-early varieties of potatoes. Presprout seed potatoes in trays under light during April and plant in early May. An acceptable crop can be harvested by mid-July, before insects have completely defoliated the plants and stopped any further growth of the tubers.

Chemical control: Apply insecticide when injury is seen and repeat the application as needed.

Recommended products: carbaryl, diazinon, dimethoate, malathion, methoxychlor, permethrin, pyrethrins, rotenone

COMMON SCAB

see Plate 21A

Common scab is a disease caused by soil-dwelling, bacteria-like organisms. Roughened, sunken or upraised discoloured patches occur on potato tubers. Deep pits on tubers are created when insects attack early infections. Neutral to alkaline soil pH, fresh manure and infected potato seed promote this disease.

❖ **TREATMENT**

Cultural control: Keep soil pH at or below 5.2. Use well-rotted manure and certified seed potatoes. Avoid growing susceptible crops for at least three years in soil where scab has been a problem. Plant scab-resistant potato varieties such as Ontario, Superior, Onaway, Russet Burbank (Netted Gem), Norchip, and Sebago. Maintain high soil moisture for about four weeks after tuber setting begins.

Chemical control: None

EARLY BLIGHT

Early blight occurs annually in most of Ontario by midsummer. Large, brown target spots appear on older leaves and spread to younger ones. Potato tubers or tomato fruit are rarely affected, but if the calyx of the tomato is infested, fruit will drop before ripening. Fungus overwinters on diseased residue.

❖ **TREATMENT**

Cultural control: Follow proper garden sanitation procedures. Vigorous plants are less susceptible. To control leafhoppers, Colorado potato beetles and blister beetles as well as early blight and late blight diseases without pesticides, plant early or medium-early varieties of potatoes. Presprout seed potatoes in trays under light during April and plant in early May. An acceptable crop can be harvested by mid-July, before extensive development of the blight.

Chemical control: Chemical treatment is seldom necessary if plants are growing healthy, young leaves, as the edible portions are unaffected. Repeat applications at 7-10 day intervals to protect young growth, especially during wet conditions.

Recommended products: chlorothalonil, copper, maneb ***

Early blight on potato leaf

HOLLOW HEART *see Plate 21B*

Hollow heart is an abiotic disorder that can affect large potato tubers. When cut in half, the centre of the tuber shows an irregular hollow area. This cavity is usually outlined in brown, and if the cracks originating at the cavity extend to the surface, the tuber may rot. As a rule, there is no decay involved and the tubers may be used with a little extra trimming.

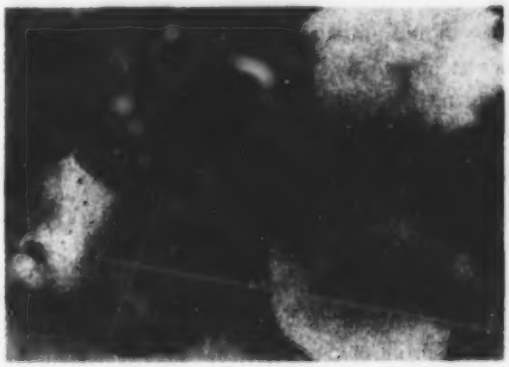
❖ **TREATMENT**

Cultural Control: Any condition such as over fertilizing that induces over-sized tubers can cause hollow heart. Proper spacing, fertilization and cultural methods will aid in avoiding this disorder. Avoid over-watering when potatoes are sizing. Severity will vary from year to year depending on growing conditions.

Chemical Control: None

LATE BLIGHT

Late blight occurs under wet, cool weather conditions during late August and September. It is usually worse on low-lying, wet land and heavier clay or clay loam soil. Brownish black blotches develop on margins of lower leaves. Disease originates from infected seed potatoes.



Above: Late blight injury on potato tubers
Below: Late blight on potato leaf

* Only available in multipurpose mixtures

** See "Resistance to benomyl", pg. 25

*** Wash vegetables treated with maneb before eating. Discard water used for boiling.

❖ **TREATMENT**

Cultural control: Use only certified seed. Destroy tubers showing dark spots when cutting seed potatoes. Once the disease shows on leaves, it spreads so rapidly that spraying is useless. Harvest the potatoes immediately, if infected in late summer, by cutting stems at ground level and waiting two weeks before digging to avoid contact with fungus spores. If contact is made, potatoes will rot in storage. Vines can be placed on compost. During digging, discard and destroy tubers with brown spots under skin.

To control late blight without pesticides, plant early or medium-early varieties of potatoes. Presprout seed potatoes in trays under light during April and plant in early May. An acceptable crop can be harvested by mid-July, before extensive development of the blight.

Chemical control: Preventive spraying may not be practical, as this disease doesn't occur every year.

Recommended products: chlorothalonil, copper, maneb ***

LEAFHOPPERS

Leafhoppers suck sap from underside of leaves, causing burning of leaf margins resembling disease or drought stress in midsummer. The insects are pale green and about 3 mm long. They move quickly when the plant is touched, making them difficult to see.

❖ **TREATMENT**

Cultural control: To control leafhoppers, Colorado potato beetles and blister beetles as well as early blight and late blight diseases without pesticides, plant early or medium-early varieties of potatoes. Presprout seed potatoes in trays under light during April and plant in early May. An acceptable crop can be harvested by mid-July, before insects have caused such extensive foliage damage that no further tuber growth is possible.

Chemical control: Spray leaves when injury or insect is noticed. Be sure the undersides of the leaves are well covered with spray.

Recommended products: carbaryl, diazinon, dimethoate, malathion, methoxychlor, permethrin, pyrethrins

Pumpkin

See Cucumber, pg. 61.

Radish, Rutabaga

See Broccoli, pg. 56.

Spinach

See Beet, pg. 56.

Squash

See Cucumber, pg. 61.

Squash

Swish Chard

See Beet, pg. 56.

Tomato

ANTHRACNOSE

Anthracnose fungi persist in soil and crop residue and cause sunken, circular spots that may completely rot the fruit. Spots usually occur late in the season during cooler, wet weather on ripe fruit in contact with the soil.

❖ **TREATMENT**

Cultural control: Keep tomatoes staked so that fruit is off the ground. Rotate crops.

Chemical control: Fungicide sprays must begin when fruit are walnut-sized and continue at 7-10 day intervals until harvest.

Recommended products: chlorothalonil, copper

* *Only available in multipurpose mixtures*

** *See "Resistance to benomyl", pg. 25*

*** *Wash vegetables treated with maneb before eating. Discard water used for boiling.*

BACTERIAL SPECK

Tiny black specks appear on leaves and fruit. Fruit is infected while green but the black lesions remain until harvest. The fruit will be edible but unsightly.

❖ **TREATMENT**

Cultural control: Purchase disease-free seed or transplants. Follow proper watering practices and avoid working in garden when plants are wet.

Chemical control: None

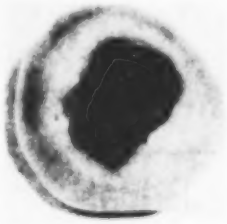
BLOSSOM-END ROT

Blossom-end rot is very common, especially on early developing fruit. Rot is brown to black becoming hard and leathery and occurs on blossom end of fruit. Later, fungi or bacteria may enter and cause soft rot of entire fruit. Injury is due to a localized calcium deficiency in the fruit developed when hot, dry weather alternates with periods of heavy rainfall. Excessive use of fertilizer, particularly nitrogen, may increase this disorder.

❖ **TREATMENT**

Cultural control: Mulch and water carefully to maintain uniform soil moisture. Do not use too much fertilizer as excessive nitrogen upsets the supply of calcium to the developing fruit.

Chemical control: None



Blossom-end rot on tomato

EARLY and LATE BLIGHT

Early blight occurs annually in most areas of Ontario by midsummer. Large, brown target spots appear on older leaves and spreads to younger ones. Tomato fruit is rarely affected. However, if the calyx of the tomato is infested, fruit will drop before ripening. Fungus overwinters on diseased plant residue.

Late blight fungus occasionally appears on tomatoes. It is reduced or prevented by fungicides used for early blight. Spray promptly and at short intervals when it appears if weather is wet.

❖ **TREATMENT**

Cultural control: Follow proper garden sanitation procedures. Remove and destroy lower infected leaves. Widely space, prune and stake tomato plants. Vigourous plants are less susceptible.

Chemical control: Chemical treatment is seldom necessary if plants are growing healthy, young leaves, as edible portions are unaffected although yield and fruit quality will be reduced. Repeat applications at 7-10 day intervals to protect young growth, especially during wet conditions.

Recommended products: chlorothalonil, copper, maneb ***

TOMATO LEAF ROLL

Symptoms are rolled edges of the leaves but the foliage retains a healthy green colour. It is not a disease caused by fungus, bacterium or virus, but it is an internal disorder of the plant probably due to irregular water supply or severe root-pruning. It has no adverse effect on plant growth.

❖ **TREATMENT:**

Cultural control: none

Chemical control: none

Tomato leaf roll

TOMATO HORNWORMS

Tomato hornworms are large, green, robust caterpillars up to 10 cm long with diagonal white stripes on sides, and a black horn on the hind end.

* Only available in multipurpose mixtures

** See "Resistance to benomyl", pg. 25

*** Wash vegetables treated with maneb before eating. Discard water used for boiling.

Leaves are eaten, leaving midrib. Holes are eaten in green fruit. Hornworm excretions are often visible near the injury. Larvae develop in summer, pupating in soil late in the season.

❖ **TREATMENT**

Cultural control: Search for larvae near injury, hand-pick and destroy. Insecticides are rarely necessary.

Chemical control: Bacillus thuringiensis is most effective if applied when caterpillars are very small.

Recommended products: Bacillus thuringiensis, carbaryl, diazinon, pyrethrins, rotenone,

SAP BEETLES

Sap beetles invade damaged tomato fruit in great numbers. They are small black beetles with four cream-coloured markings.

❖ **TREATMENT**

Cultural control: Gather and discard damaged fruit. Use halves of overripe melon or bananas as bait. Remove bait regularly and destroy beetles with old bait.

Chemical control: Use bait as directed on label.

Recommended product: carbaryl (bait)

SEPTORIA LEAF SPOT or BLIGHT

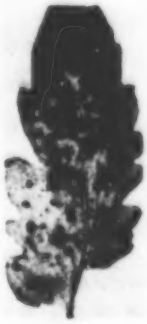
Septoria leaf spot or blight has been a common problem in recent years. Spots are reddish at first but later develop grey centres with black dots. Spots will occur on the stems and branches.

❖ **TREATMENT**

Cultural control: Purchase hot-water treated seed. Follow garden sanitation procedures.

Chemical control: If this disease is a problem, apply fungicide and repeat at 7-10 day intervals.

Recommended products: chlorothalonil, copper



Septoria leaf spot on tomato leaflet

WHITEFLIES

The adults are small white insects that cause little feeding damage but lay masses of eggs. The scale-like nymphs (juvenile stage) are sap suckers and cause leaves to wither. In addition, the production of sticky honeydew by the feeding nymphs usually leads to the growth of sooty mould.

Whiteflies multiply quickly, which makes control difficult. Swarms of small white flies are noticeable when plants are disturbed, and nymphs are found in large numbers only on the underside of leaves.

❖ **TREATMENT**

Cultural control: None

Chemical control: For control outdoors, spray at weekly intervals but be sure to apply the insecticide to the underside of leaves as well as the upper surface. The whitefly does not overwinter outdoors.

Recommended product: permethrin

Zucchini

See Cucumber, (pg. 61).

• 6 •

FRUIT

PROBLEM AREAS ON FRUIT PLANTS

Use the following information to identify the cause of your fruit tree problems. Examine the damage on the tree and then refer to the corresponding section. Similar symptoms can result from different problems. When in doubt, consult a qualified specialist for advice.

Roots

Roots rotted, fine fibrous roots, bark strips off easily, discoloured wood underneath.

- root rot fungi, waterlogged soil
- tree planted too deeply
- tree planted in compacted or improper soil
- nematodes

Roots or lower stem have tumor-like growth

- crown gall bacteria

Trunk and Branches

Sunken, discoloured, missing or split areas of bark, often with cracked edges; pimple-like structures or gum production on bark.

- canker-causing fungi
- bacterial fire blight
- winter injury (especially on the south and west sides of the tree)
- improper pruning
- mechanical wound (lawn mower, etc.)

Bark missing, teeth marks in wood

- field mouse or rabbit feeding

Small holes in bark with evidence of sawdust; tunnels underneath bark

- wood-boring insects

Cross-section shows brown staining in wood; may have shelf-like fungi on the bark

- verticillium wilt fungus
- wood decay fungus
- silver leaf fungus

Swollen, dark green to black areas of bark on plum or cherry

- black knot fungus

Small twigs or entire branches die back; buds are brown inside, dried up or rotted

- winter injury
- canker-causing fungi
- bacterial blights
- brown rot (peach, plum, cherry)
- borers

Small bumps on bark that are easily removed with a sharp object

- scale insects

Leaves

Leaves do not emerge, or wilt, discolour and die

- abiotic injury: winter injury, severe drought
- plant girdled by borers, twine, wire or rodent
- canker-causing fungi
- verticillium wilt
- root rot fungi

Leaves turn black or brown on part of plant and remain attached

- fireblight (apple, pear)
- brown rot (peach, plum, cherry)

Presence of sticky, shiny honeydew covered with black, sooty mould

- sucking insects such as aphids
- scale
- pear psylla
- sooty mould

Speckled or discoloured; may dry out and turn bronze or brown

- spider mites, European red mite
- leafhoppers

Covered with white powdery mould

- powdery mildew

Warts or abnormal growths

- gall mites

Puckered, contorted, stunted appearance

- peach leaf curl
- aphids
- pear psylla

Twisted, cupped, yellow, strap-like appearance

- herbicide injury

Presence of olive-green to black, felt-like patches

- apple scab, pear scab

Edges dry and brown

- drought

Small orange, grey, tan, or brown spots on leaves; sometimes dried tissue falls out, leaving holes

- frog-eye leaf spot on apple
- cherry leaf spot on cherry
- cedar apple rust

Leaves are eaten

- large holes: caterpillars
- green parts eaten, only veins remain: skeletonizers (e.g. pear slug, caterpillars)
- rolled or webbed together: tent caterpillars, leafrollers
- hollowed-out areas: leafminers

Fruit

No fruit development

- winter injury, frost injury
- poor pollination
- excessive fertilization
- immature tree

Fruit drops early

- normal June drop due to excessive fruit set
- insect infestation inside fruit: curculio, maggots, caterpillars
- carbaryl insecticide used just after bloom
- excessive pest injury to leaves (tentiform leafminer)

Blemishes

- half-moon scar: plum curculio
- sunken dimples: apple maggot on apple or prune (Italian or Stanley); plant bug on apple, pear, peach; cherry maggot
- holes in fruit, may have sawdust-like frass: codling moth on apple and pear; oriental fruit moth on peach
- tiny brown knobs which can be scraped off easily: scale insects
- rotted, tan to dark brown spots: fungus diseases — black rot on apple, brown rot on peach, plum and cherry
- dark olive-green to brown felt-like patches, sometimes skin cracks: apple scab, pear scab

Fruit rot on the tree or after harvest

- soft, watery rot covered with white and black whisker-like mould: Rhizopus rot (peach, plum, cherry)
- soft, brown rot covered with greyish-brown, velvety mould: Brown rot (peach, plum, cherry)
- firm, dark brown, target-like rot: Black rot (apple, pear)
- watery, tan, sunken rot with blue-green and white tufted mould: Penicillium rot (apple, pear)

Small, poorly developed fruit

- Excessive fruit set
- Reaction to nearby feeding of aphids
- Pear psylla or other sucking insects
- Cedar apple rust or quince rust infections

INSECT AND DISEASE CONTROL ON FRUIT

Preventive Measures

To guard against problems with your fruit trees, follow good cultural practices (pg. 17) such as pruning and destroying affected fruit. Buy only varieties of fruit that are known to be compatible for cross-pollination.

Poor Flowering, Pollination and Fruit Set

Pests are not the only cause of poor flowering. Abiotic damage is often the culprit. This includes:

- temperature extremes or fluctuations during winter that kill flower buds
- early spring frosts, after flower buds have begun to swell, that kill flower tissue
- over-fertilization or excessive pruning during the previous season that results in excessive vegetative growth

Poor fruit set can occur for a variety of reasons as well:

- damage to pistil and stamens before the flower blooms prevents pollination and fertilization
- cool, wet weather during bloom discourages pollination by bees
- excessive fruit load during previous growing season, particularly in apples and pears, will reduce fruit load in the current growing season. To minimize this problem, thin fruit in late June or early July.

Some fruit are self-fruitful — they will pollinate themselves without requiring a second cross-pollinating tree. Others such as sweet cherries are cross-pollinated and require other trees with compatible pollen in the area; some, such as apples, also require varieties with a similar flowering date. Be sure to purchase named varieties which are compatible for cross-pollination.

Pesticides

Some of the pest problems described in this manual are common in commercial operations, but may not occur in your home garden if you are not located in a commercial fruit production area. Spraying for them is unnecessary and unwise. Keep in mind, however, that neglected apple, pear and plum trees, which grow throughout Ontario, are sources of many harmful insects and diseases.

For a successful treatment program, careful timing of sprays and thorough application of the correct pesticides are necessary. For a complete pesticide discussion, including resistance to benomyl fungicide, rate of application and mixing products together, please see pg. 21.

Recommended Products

The pesticides on the following pages are listed by their common chemical name in alphabetical order, not in order of preference. These names are the active ingredients of a product and are included on the product label. The lists on pg. A-5 relate common chemical names to corresponding products sold in Ontario at the time of publication.

Insecticides

To control certain insects, apply preventive sprays before eggs are laid. The insects which require preventive spraying are listed on the following pages.

Fungicides

Preventive fungicide applications are necessary to protect foliage and fruit against fungal infection. If applied after infection takes place, most fungicides can not stop development of the disease, but they may prevent further spread. Repeat applications are required to protect new foliage and to renew protection. Fungicides are not harmful to bees.

Apply fungicides before rainfall to allow residue time to dry and reduce loss during rainfall.

No-Spray Interval

A product's no-spray interval is the time that must be allowed between the last application and the harvesting of the fruit to avoid harmful residues. It varies for each product and each kind of fruit. Consult the product label for the no-spray interval and follow the instructions carefully.

Spray Programs

Prevention of many insects and diseases is necessary and easier to achieve by following a spray program, particularly for fruit trees. Spray programs for apple, pear, peach, plum, cherry, nectarine and apricot are provided in tables 10 and 11 at the end of this chapter.

DESCRIPTIONS AND TREATMENTS

Insects and diseases are listed under each fruit. If, however, you cannot find the pest to suit your symptoms, look in the "All Fruit" section below.

Where a disease or insect applies to more than one fruit, the full discussion is provided only once, and page references provided for all other fruits.

Egg mass of tent caterpillar

Right: Tent caterpillar on tent

All Fruit (except strawberry)

CROWN GALLS

Crown galls are caused by bacteria present in most garden soils that gain entrance through wounds in the plant. It is common on all types of fruit trees, raspberries, grape, bush fruits, and many others. Galls or woody swellings develop on the roots or base of a plant.

❖ **TREATMENT**

Cultural control: Remove galls with a sharp clean knife or secateurs. Clean tools and hands in a solution of 1 part bleach to 4 parts water to prevent further spread. Whenever possible, avoid unnecessary wounds, and do not buy plants with galls on roots. Replace soil where a severely affected plant has grown.

Chemical control: None

CATERPILLARS

Several kinds of caterpillars damage fruit trees. The tent caterpillar is the most common, building large silken nests in the branch forks. Tent caterpillars are black and hairy with white stripes on their back and narrow brown and yellow lines with blue dots on their sides. Leafrollers spin a light web around leaves, rolling them together. They feed inside the protected area from shortly after buds open until about three weeks after petal fall.

❖ **TREATMENT**

Cultural control: When tents are noticed in spring, remove and destroy caterpillars or prune the affected twigs and branches. Do this in the evening when most worms are in the tent. In early spring, prune out or rub off egg masses. They appear as dark brown, styrofoam-like collars 1 cm wide around twigs and branches.

Chemical control: Spray only if many tents are found or if other types of caterpillars are a problem. Apply insecticides before leaves are rolled and tied together, because caterpillars will not consume or be touched by the residue if protected in a silken shelter. Carbaryl causes dropping of small apples if applied during the three-week period after bloom.

Recommended products: carbaryl, diazinon, permethrin, phosalone*, phosmet (not on sweet cherry)

CURCULIOS

see Plate 22

Curculios are 6 mm dark brown weevils with prominent snouts that lay eggs in apple, pear, plum and occasionally peach and cherry soon after flower petals have fallen. A crescent-shaped scar develops on the fruit. Wounds on apple often exude sap that dries to a white crust. The greyish white larvae tunnel in the fruit and cause it to drop early.

❖ **TREATMENT**

Cultural control: Spread a sheet of plastic under the tree and shake the branches. Adults will fall onto the sheets and can be destroyed. Remove and destroy all fallen fruit.

Chemical control: Spray after bloom as soon as most petals have fallen and repeat 10 days later. Carbaryl used at this time causes dropping of small apples but does not affect other fruit.

Recommended products: carbaryl, diazinon, permethrin, phosalone*, phosmet* (not on sweet cherry)

MITES

Mites are tiny spider-like red or brown pests that feed on the underside of leaves. They are difficult to see without the aid of a hand lens. Mites suck the chlorophyll from the leaves causing small white dots and bronzing when severe. Control measures are not necessary unless the leaves start to turn bronze, usually during hot, dry weather.

❖ **TREATMENT**

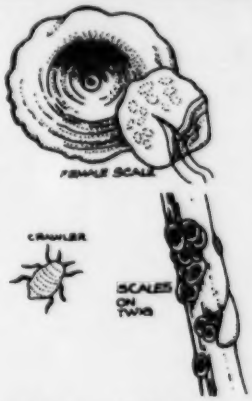
Cultural control: On young or dwarf trees, blast the undersurface of the leaves with water to wash mites away. Repeat every couple of days. This approach is not successful on large trees.

Chemical control: Other pest sprays (except carbaryl and methoxychlor) may keep mite populations at acceptable levels, making special sprays unnecessary. Repeated use of carbaryl for the control of other insects may lead to an increased mite population. Dormant oil can be applied in the spring at the half-inch green stage (see pg. 91) to kill red mites that overwinter on fruit trees, but not mites that overwinter elsewhere.

Recommended products: dormant oil spray, dicofol*, dimethoate (for severe infestation only), insecticidal soap, phosmet*

Caution: If applying dormant oil for scale control, do not use for mite control. Spray oil in the morning to allow quick drying. Injury will occur if dormant oil spray is not completely dry before a cold night.

SCALE INSECTS



Scale insects live under hard-shelled caps or scales on the bark of trees and cause damage by sucking sap and reducing the vigour of the tree. Depending on the species, scales look like small grey oyster shells or round brown knobs.

❖ **TREATMENT**

Cultural control: A light infestation may be kept in check by birds and beneficial insects.

Chemical control: The only effective control is an early spring application while buds are still dormant. If severe, spray the following spring before leaf buds break, thoroughly wetting bark. Dormant oil may cause some bark injury on the Red Delicious apple.

Recommended products: dormant oil, lime sulphur

Caution: Spray oil in the morning to allow quick drying of the spray. Injury will occur if oil spray is not completely dry before a cold night.

SILVERLEAF

Silverleaf is caused by a fungus that invades trees through pruning wounds. Apples, apricots, gooseberries, peaches, plums, raspberries and sour cherries, as well as several woody ornamentals are susceptible. Symptoms include the development of a metallic, silver sheen on the leaves and browning and streaking inside the branches. Branches or entire trees may be killed once the sapwood is invaded. The fungus produces shelf-like fruiting bodies up to 2.5 cm in diameter under branches and in the bark. These bodies are abundant and bright purple after autumn rains.

❖ **TREATMENT**

Cultural control: Avoid pruning trees when they are most susceptible to infection, from sap flow in early spring until after bloom. If possible, avoid large pruning cuts. Remove dead trees and tree branches nearby which might be sources of the fungus. Removing affected branches may not save an infected tree, as the fungus is often well established throughout the tree by the time symptoms develop.

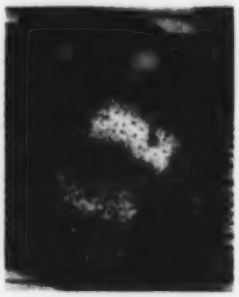
Chemical control: None

* Only available in multipurpose mixtures

** See "Resistance to benomyl" pg. 25

PLANT BUGS

Plant bugs feed with their piercing, sucking mouthparts on young developing apples, peaches, pears, and nectarines causing sunken pits — catfacing — to form. Peaches, apricots and nectarines may also secrete an amber gum. On peach trees particularly, the insects also feed on young shoots, causing wilting and dying back.



Plant bug injury to pear

Adult tarnished plant bugs (TPB) are brown, while the four-lined plant bugs (FLPB) are greenish-yellow with four black stripes. Both are triangular in front, 6-7 mm long and about half as wide. They are very active, readily flying when disturbed. Young TPB are light green, while young FLPB are bright red, each with dark spots and markings. TPB can be a problem throughout the season, while FLPB is prevalent in late spring and summer.

❖ **TREATMENT**

Cultural control: Thoroughly clean the garden in the fall as plant bugs overwinter as nymphs or adults in garden trash and weeds.

Chemical control: Insecticide may be applied when plant bugs are first noticed in spring, especially after flowering when young fruits are expanding, and later when migrating adults appear.

Recommended products: carbaryl, permethrin (not on pear), phosmet*

Apple, Crabapple◆

◆ Ornamental fruiting crabapples are attacked by the same insects and diseases as apples. See also section on ornamental plants.

CODLING MOTHS

see Plates 23 & 24

The adult codling moth is greyish brown with lacy lines on forewings and fringed hindwings. The larva is 2.5 cm long, pink, with a brown head. Eggs are laid on the fruit and the larvae enter and grow inside. Dark sawdust-like material is evident at the entry hole and infested fruit often drops before maturity.

❖ **TREATMENT**

Cultural control: Regularly gather and destroy dropped fruit by throwing it in the garbage can or burying it at least 60 cm deep. This will reduce the insect population next summer.

Chemical control: As eggs are laid from mid-June until mid-August, spray at about 12-day intervals during that period. Sprays for codling moth and apple maggot are similar in timing and material (except for dimethoate), and you can therefore use one of the recommended insecticides for both insects. Observe the product's no-spray interval before harvest.

Recommended products: carbaryl, diazinon, permethrin, phosalone*, phosmet*

BLACK ROT AND FROG-EYE LEAF SPOT

Black rot on fruit and frog-eye leaf spot on leaves are fungal diseases. They often occur on unsprayed trees in late summer just before fruit maturity. Small, tan-centred spots with darker borders — frog eyes — appear on the leaves. On fruit, small, purple or red spots turn dark brown as they expand; older, larger spots may also have rings of black specks.

Affected fruit will rot completely in storage. The fungus survives in fruit on and under the trees, as well as in cankers and dead twigs.

❖ **TREATMENT**

Cultural control: Destroy mummified fruit and prune out infected branches.

Chemical control: The spray program for apple scab will control this disease. See pg. 75.

FIRE BLIGHT

Fire blight, caused by bacteria, is most serious on pears and occasionally affects apples.

For a full discussion, see Pears, pg . 83.

SCAB

see Plates 25 & 26

Scab is the most common and serious disease of apples throughout Ontario. Occasionally, it will also affect pears, especially "Flemish Beauty". Olive-green spots appear on leaves; with time, they turn dark brown and black. On fruit, dark, irregular spots appear; if spotting is severe, the skin cracks and the fruit is deformed. Leaves may drop and the crop in the following year may be reduced. The fungus which causes the scab overwinters on dead leaves on the ground. Spores are discharged into the air by spring rain and infect young apple leaves and fruit.

❖ TREATMENT

Cultural control: Gather and eliminate fallen leaves in autumn. Unfortunately, if there are neglected apple trees in the immediate area, this will not be effective. Once the scab fungus becomes established on a tree, each rain causes new infections.

Chemical control: Prevent infection by covering leaves and blossoms with fungicide spray. In spring, repeated spraying is required to protect the rapidly developing new growth. First spray should be applied when tips of the leaves appear. Repeat at 5-7 day intervals until mid-June. If no scab is visible, fungicide applications can be discontinued. If scab is visible, continue fungicide applications on a 10-14 day schedule until mid-August. See spray program, pg. 92.

Recommended products: benomyl** (not on pear), captan, ferbam*, lime sulphur (not on pear), sulphur (spray). (Do not use captan with dormant oil or within 10 days of an oil spray.)

TENTIFORM LEAFMINERS

Tentiform leafminer larvae leave speckled blotches of tented, hollowed out leaf tissue. Adults are tiny (3-4 mm long) moths with brown and white markings. There are three generations per year. The first begins in spring when eggs are laid on the underside of new leaves at the tight cluster stage to pink stage of blossom development (see pg. 91). Larvae feed between leaf surfaces for 4 to 5 weeks where they create mines or tunnels. They pupate in the mines and then emerge to complete one generation. Low to moderate levels of leafminers (1-7 mines per leaf) do not require control. High levels of infestation, however, will cause the fruit to be undersized and will lead to premature fruit drop.

❖ TREATMENT

Cultural control: Damage by the leafminer is more severe when trees have been stressed. The best prevention, therefore, is to maintain the health of your trees.

Chemical control: If leafmining has been severe, the first generation to appear the following season must be controlled to prevent late season population growth and indirect injury to the fruit crop. The trunk, large branches and leaves must be thoroughly sprayed. Be sure not to spray permethrin when blossoms are open, as pollinating bees will be killed.

Recommended product: permethrin

APPLE MAGGOTS OR RAILROAD WORMS

see Plates 27 & 28

Apple maggots, or railroad worms, are a problem in most areas of Ontario. The 6 mm long adult fly is black with yellow legs and yellow markings on its abdomen. It lays its eggs on the fruit from late June until mid-August. The small white maggots that emerge create extensive tunnels, causing the surface to be bumpy and the fruit to drop. When full-grown, the maggots move from the overripe fruit into the soil where they overwinter. If unsprayed apple trees are in the neighbourhood, this insect is very difficult to control.

❖ TREATMENT

Cultural control: Hang sticky red balls or yellow traps, available at garden centres, in the tree to trap the adults and prevent egg laying. Gather the fruit as it drops and throw it in the garbage can or bury it at least 60 cm deep to reduce maggot flies and damaged fruit the following summer. Encourage your neighbours to do the same. Destroy wild and unsprayed apple, prune and hawthorn trees in the vicinity if possible.

Chemical control: Spray leaves and fruit to kill flies before egg laying. Spray about every 12 days from

* *Only available in multipurpose mixtures*

** *See "Resistance to benomyl" pg. 25*

late June until mid-August, but observe the no-spray interval as stated on the product label.

Recommended products: carbaryl, diazinon, dimethoate, permethrin (not on prune), phosalone*, phosmet*

POWDERY MILDEW

Powdery mildew is sometimes a problem on the young shoots of apple trees. The most susceptible varieties are Cortland, Ida Red and Jonathan. It causes distorted, rolled leaves with white velvety fungus growth on the upper surface. Severely infected shoots are dwarfed.

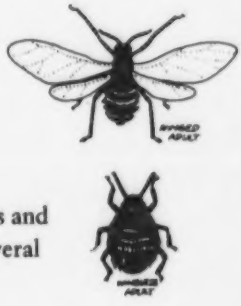
❖ TREATMENT

Cultural control: Prune out infected terminal shoots. Improve air circulation around the tree.

Chemical control: Spray when first noticed and repeat until the symptoms disappear.

Recommended product: benomyl** (not on pear), dinocap*, sulphur

ROSY APPLE APHIDS



Rosy apple aphids overwinter as eggs at the base of buds. The eggs hatch as the buds unfold and immature larvae begin to feed on leaf and flower bud clusters, resulting in rolled leaves and clusters of misshapen apples. Several generations occur each year.

❖ TREATMENT

Cultural control: Syrphids, ladybugs and lacewings are good natural predators of aphids and often will keep populations below damaging levels.

Chemical control: If this pest was a problem during the previous year, spray just before blossoms open but not during bloom.

Recommended products: dimethoate, phosalone*

APHIDS

Aphids are soft bodied greenish to brown, pear-shaped insects 5 mm in size. They are a common problem on apple and sweet cherry and less so on sour cherry. They attack the growing end of twigs throughout the summer, sucking sap and causing leaves to curl, pucker and turn yellow. Fruit is affected when infestation is severe. A sooty deposit is found on the apple fruit. Control is very difficult once this insect becomes established and leaves are curled.

❖ TREATMENT

Cultural control: Syrphids, ladybugs and lacewings are good natural predators of aphids and often will keep populations below damaging levels.

Chemical control: Spray apple trees when aphids are abundant and repeat as necessary. If aphids infested sweet cherry the previous year, spray when leaf buds break. Insecticidal soap is not effective for cherry aphid.

Recommended products: diazinon, dimethoate, insecticidal soap, phosalone*

Apricot

CYTOSPORA CANKERS

Cystospora is a fungal infection occurring on the trunk and lower branches that usually enters through wounds in the tree. Twigs develop brownish-black areas around winter-killed buds or scarred areas on the bark. By early summer, a gummy substance appears, and later the bark separates from the wood. The cankers grow larger every year, and are most conspicuous on the main trunk or scaffold branches.

❖ TREATMENT

Cultural control: As cytospora enters through wounds in the tree, your best defence is to control for peach tree borers (see below) and to avoid bark injury, long pruning stubs, winter injury, or brown rot injury to twigs. Prune trees in spring, not fall, and remove any dead wood before the end of June. Do not prune in cool, wet weather. Do not apply fertilizer after June. Healthy trees growing on well-drained, deep, sandy soil are less likely to get cankers.

Chemical control: None

* *Only available in multipurpose mixtures*

** *See "Resistance to benomyl" pg. 25*

PEACH TREE BORERS

Peach tree borers attack peach, nectarine, apricot and sometimes plum and cherry trees.

For a full discussion, see Peaches, pg. 82.

BACTERIAL SPOT

Bacterial spot causes small, round, tan spots to appear on leaves which later turn purplish and angular. Small, sunken, round spots also appear on the fruit and later the fruit cracks. Extended periods of wet weather encourage the spread and development of the bacteria.

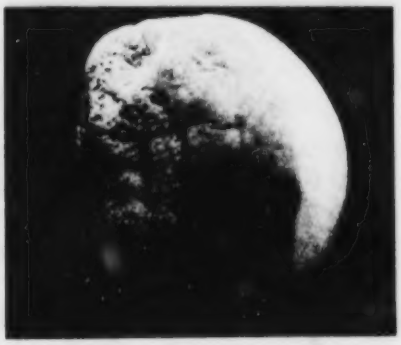
❖ **TREATMENT**

Cultural control: Remove all fruit at harvest and remove infected leaves regularly.

Chemical control: None

BROWN ROT

Brown rot is a fungus that attacks various parts of the tree. Blossoms that become infected shrivel, twigs are killed, and fruit becomes covered with grey-brown mould and rots rapidly. Infected fruit may drop or hang on the tree throughout the winter, and mould can develop on the fruit even after harvesting.



Brown rot on peach

❖ **TREATMENT**

Cultural control: Throw all mouldy fruit in the garbage or bury it to reduce infection next summer. Cut dried fruit (mummies) out of trees when pruning and dispose of it in the same manner early in the fall.

Chemical control: Spray when symptoms are first noticed and repeat at two-week intervals until late July. If brown rot occurred in the previous year, spray when blossom petals fall and repeat about 10 days later; spray again in the first 10 days of July (depending on geographic location) and repeat 14 days later. If brown rot is present and wet weather prevails, further sprays may be needed. Observe the product's no-spray interval before harvest.

Recommended products: benomyl**, captan, sulphur

Blackberry

See Raspberry, pg. 85.

Blackberry

Blueberry

In Ontario, blueberries have few insect and disease problems. No domestic pesticides are registered for this crop.

Cherry

APHIDS

Aphids are soft bodied greenish to brown, pear-shaped insects 5 mm in size. They are a common problem on apple and sweet cherry and less so on sour cherry. They attack the growing end of twigs throughout the summer, sucking sap and causing leaves to curl, pucker and turn yellow. Fruit is affected when the infestation is severe. Control is very difficult once this insect becomes established and leaves are curled.

❖ **TREATMENT**

Cultural control: Syrphids, ladybugs and lacewings are good natural predators of aphids and often will keep populations below damaging levels.

Chemical control: Spray trees when aphids are abundant and repeat as necessary. Spray sweet

* Only available in multipurpose mixtures

** See "Resistance to benomyl" pg. 25

cherry when leaf buds break if infestation was severe the previous year. Insecticidal soap is not effective for cherry aphid.

Recommended products: diazinon, dimethoate, phosalone*

PEAR SLUGS

Pear slugs are the larvae of sawflies and are not true slugs. For a full discussion, see Pears, pg. 84.

PEACH TREE BORERS

Peach tree borers attack peach, nectarine, apricot and sometimes plum and cherry trees. For a full discussion, see Peaches, pg. 82.

BROWN ROT

Brown rot is a fungus that attacks various parts of the trees. For a full discussion, see Apricots, pg. 77.

BLACK KNOT

Black knot affects plum and sometimes cherry. For a full discussion, see Plums and Prunes, pg. 85.

CHERRY MAGGOTS

Cherry maggots are related to apple maggots. The small adult fly lays eggs on developing fruit in late spring and early summer and the maggot tunnels into fruit, causing it to be small and misshapen and to fall prematurely. The maggot is yellowish-white, legless and has two dark mouth hooks. Both sweet and sour cherries are attacked. A cherry crop infested with maggots is not worth harvesting.

Cherry maggot and injury

❖ TREATMENT

Cultural control: Because the insects will overwinter in the soil under the tree, gather infested fruit and discard it in the garbage or bury it at least 60 cm deep. Encourage your neighbours to do the same.

Chemical control: Spray between July 1 and 10, depending on geographic location. If cherry maggot was a serious problem in the previous year, apply a spray 10 days earlier. Observe the product's no-spray interval before harvest. If unsprayed cherry trees grow in the neighbourhood, control is usually unsatisfactory.

Recommended products: carbaryl, diazinon, dimethoate, phosalone*

LEAF SPOT

Leaf spot often occurs on sour cherry, but rarely on sweet cherry. Many small, red-purple spots first appear on the leaves, holes then develop, and the leaves eventually yellow and drop. The tree is weakened if this happens during successive years.

❖ TREATMENT

Cultural control: Rake up and destroy infested leaves as they fall to reduce the level of overwintering of the disease.

Chemical control: When leaf spot has been a problem, spray when blossom petals fall and repeat about 10 days later; spray again between July 1 to 10 and after harvest. Observe the product's no-spray interval before harvest.

Recommended products: benomyl**, captan

Leaf spot on cherry

* *Only available in multipurpose mixtures*

** *See "Resistance to benomyl" pg. 25*

Currant and Gooseberry

APHIDS

Aphids are soft-bodied, greenish to brown, 5mm, pear-shaped insects. They are often a serious problem on currants, especially red currants. They cause leaves to pucker, curl and show red blisters.

❖ **TREATMENT**

Cultural control: None

Chemical control: If this problem has occurred before, spray when leaf buds open in spring and repeat 10 days later. Early season applications are critical, since aphids are very difficult to control once leaves are curled.

Recommended product: insecticidal soap, malathion

CURRANT BORERS, CURRANT STEM GIRDLERS

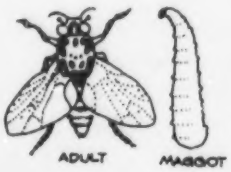
Currant borers and currant stem girdlers cause injury to the wood of the canes. Affected shoots look sickly with small, yellowed leaves. Eventually, the shoots will die.

❖ **TREATMENT**

Cultural control: Shoots should be cut out and destroyed when symptoms are noticed at any time of the year. Shoots older than three years are less productive and should be removed in spring before leaf buds break to minimize the potential for attack. Apply manure to promote vigorous growth of new canes.

Chemical control: None

CURRANT FRUIT FLIES



Maggots in the fruit are larvae of currant fruit flies. Infested berries ripen prematurely and many drop to the ground.

❖ **TREATMENT**

Cultural control: Remove and destroy infested berries to reduce risk the following season.

Chemical control: Treat if maggots were a problem last year. Flies must be killed before they lay eggs. For currants, spray just after bloom and again a week later. For gooseberries, spray when berries turn red.

Recommended products: malathion, methoxychlor, rotenone

CURRANT SAWFLIES

The larva of the sawfly is 2.5 cm long, green, with many legs and a black spotted body. It eats the leaves of gooseberries and red or white currants (not black currants) as plants come into full leaf. The adult is a small black wasp-like insect.

❖ **TREATMENT**

Cultural control: None

Chemical control: Treat when worms appear and repeat as needed.

Recommended products: methoxychlor, rotenone

LEAF SPOT

Fungal leaf spot diseases are often the cause of early defoliation. Spots are first brown and later grey; leaves yellow and drop.

❖ **TREATMENT**

Cultural control: Gathering and destroying infected leaves after they have dropped can be a very effective sanitation method if done thoroughly. If mulch is used, apply fresh mulch after leaf fall.

Chemical control: If leaf spot disease has been a problem in previous years, apply a preventive spray just before blossoms open. If leaf spots still develop, spray again after bloom.

Recommended product: copper

POWDERY MILDEW

Powdery mildew is a problem mainly on gooseberry and black currant. The fungus initially appears as a white fluffy mildew that later turns to a brown, felt-

like coating on leaves, twigs, and fruits. Hot, humid weather favours the disease.

Powdery mildew on gooseberry

❖ **TREATMENT**

Chemical control: Spray only with lime sulphur prior to bud break and again just before bloom with one of the three fungicides listed.

Recommended products: copper, lime sulphur, sulphur

Caution: Follow instructions carefully on the product label when using lime sulphur, because dormant concentrations are stronger than those used after bud break, and will injure leaves if applied too late.

RUST

The rust fungus spends part of its life cycle on white pine, but requires the currant or gooseberry as a host to complete its life cycle. Only the black currant, however, is defoliated. Orange spots, later growing into pimples, appear on the lower surface of leaves.

For more information on white pine blister rust, see pg. 119.

❖ **TREATMENT**

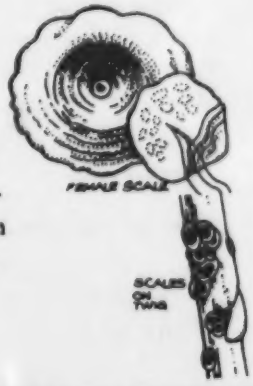
Cultural control: The Consort black currant is resistant to white pine blister rust. Avoid planting currants and white pine near each other.

Chemical control: Spray just before bloom and again after harvest.

Recommended products: lime sulphur, sulphur

SCALE INSECTS

Scale insects, particularly San Jose scale, are often found on shoots. The scales are up to 4 mm across, round, with a greyish, nipple-shaped projection in the centre that contain lemon-yellow, sack-like insects.



❖ **TREATMENT**

Cultural control: None

Chemical control: Spray thoroughly before leaf buds break. Spray dormant oil in the morning to allow drying before a cold night.

Recommended products: dormant oil, lime sulphur

GRAPE

BERRY MOTHS

Berry moths are a problem only in areas where grapes are grown commercially. The adult is a 6 mm brown-bodied moth with blue-grey wings that have cream spots near the tips. The larvae are initially cream-coloured with a brown head but become green and then purple when mature. The first generation larvae web together buds, flowers and newly set berries and chew them. The second generation burrow into green berries near the stem. Berries usually shrivel or fall off.

❖ **TREATMENT**

Cultural control: Remove nearby wild grapevines. Bury leaf debris.

Chemical control: If wormy fruit has been a problem, spray after blossoming period and again 12 days later. If it has been a serious problem, spray again just before bloom and on late varieties again about August 20.

Recommended products: diazinon, permethrin, phosalone*, phosmet*

BLACK ROT

Black rot can be a serious problem on many grape varieties including Catawba, Concord, Agawam and Niagara. Raised black lesions develop on cluster and leaf stems and on new shoots. Infected berries develop a reddish-brown ring and shortly before harvest shrivel into blue-black mummies.

❖ **TREATMENT**

Cultural control: Remove infected debris before the start of the growing season. Cultivate early in season to bury infected mummies and remaining debris.

Chemical control: Preventive sprays have to be applied just before, and again shortly after, bloom.

Recommended products: benomyl**, copper, ferbam

GRAPE FLEA BEETLES

The grape flea beetle is a shiny, metallic, greenish-blue beetle that attacks opening buds in spring. It is 4 - 5 mm long and jumps when disturbed. The adult chews through the ends and sides of swelling buds. Larvae are black-spotted grubs which feed on leaves.

❖ **TREATMENT**

Cultural control: Examine vines in May. If practical, knock the adults off into a pail of soapy water.

Chemical control: Examine vines in May (as buds swell) for adults. Spray if numbers warrant.

Recommended product: diazinon

DOWNY MILDEW

Downy mildew appears early in the season and affects leaves, tendrils, shoots and fruit, covering these with heavy, white, downy fungus underneath and localized pale yellow areas on top surfaces. Fruit clusters may curl or be completely destroyed. The disease is more serious in wet seasons and in sheltered areas with poor air movement.

❖ **TREATMENT**

Cultural control: Prune to allow good air movement. Collect and destroy infected plant material. Cultivate in spring to bury any remaining infected tissue. Agawam, Delaware, Fredonia, Niagara and Van Buren varieties are especially susceptible. Plant other varieties to avoid the need for fungicides.

Chemical control: Spray just before bloom but after flower clusters have expanded. Additional sprays may be necessary, depending on weather and disease conditions.

Recommended products: captan, copper, folpet

POWDERY MILDEW

Powdery mildew usually appears later than downy mildew but may be present just after bloom. Blossoms wither and drop, whitish patches appear on upper leaf surfaces in shaded areas of the vine, and fruit may crack and fail to ripen. If the fruit stem is infected, berries drop. Prolonged humid conditions favour its growth.

❖ **TREATMENT**

Cultural Control: Prune to allow good air circulation and to reduce shading. Agawam, Buffalo, Concord, DeChaunac, Fredonia, Foch, New York Muscat and Seneca varieties are especially susceptible. Plant more resistant cultivars if possible.

Chemical Control: Spray thoroughly just after bloom (mid-to-late June) and repeat again during the first week of August or when mildew appears. Further applications may be necessary.

Recommended products: benomet**, folpet, sulphur

Caution: Do not spray sulphur on sulphur-sensitive varieties such as Concord, Foch, Ives and Van Buren.

Nectarine

CYTOSPORA CANKER

Cystospora is a fungal infection occurring on the trunk and lower branches that usually enters through wounds in the tree. For a full discussion, see Apricots, pg. 76.

LEAF CURL

Leaf curl causes leaves to curl and reddish blisters to appear. Eventually, leaves turn yellow and drop. Tree is weakened if disease occurs several years in succession.

❖ **TREATMENT**

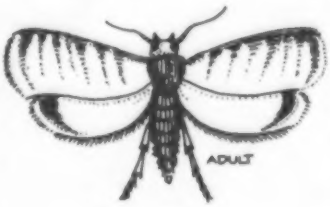
Cultural control: Remove and destroy infected leaves as they appear in the spring.

Chemical control: Spray either in spring before buds break or in autumn after leaves have fallen. Sprays are not effective at other times.

Leaf curl on peach

Recommended products: ferbam*, lime sulphur

ORIENTAL FRUIT MOTHS



The larvae of oriental fruit moths are the worms commonly found in peaches and nectarines. Larvae overwinter on the ground in weeds and mummified fruit. They pupate in the spring, emerging in late May or early June as 6 mm grey moths with chocolate-brown markings on wings. The first larvae enter young twigs, which wilt and die. Later generations enter ripening fruit. It is a problem in areas where these fruits are grown commercially, and may not occur in isolated locations.

❖ TREATMENT

Cultural control: Remove and destroy all infested fruit from under trees.

Chemical control: Spray between July 1 and 10, depending on geographic location and repeat two weeks later. Observe the product's no-spray interval before harvest.

Recommended products: carbaryl, permethrin, phosalone*, phosmet*

PEACH TREE BORERS

Peach tree borers attack peach, nectarine, apricot and sometimes plum and cherry trees. For a full discussion, see Peaches, below.

BACTERIAL SPOT

Bacterial spot causes small, round, tan spots to appear on leaves which later turn purplish and angular. For a full discussion, see Apricots, pg. 77.

BROWN ROT

Brown rot is a fungus that attacks various parts of the tree. For a full discussion, see Apricots, pg. 77.

Peach

CYTOSPORA CANKERS

Cystospora is a fungal infection occurring on the trunk and lower branches that usually enters through wounds in the tree. For a full discussion, see Nectarines, pg. 81.

LEAF CURL

Leaf curl causes leaves to curl and reddish blisters to appear. For a full discussion, see Nectarines, pg. 81.

ORIENTAL FRUIT MOTHS

The larvae of oriental fruit moths are the worms commonly found in peaches and nectarines. For a full discussion, see Nectarines, this page.

PEACH TREE BORERS

Peach tree borers attack peach, nectarine, apricot and sometimes plum and cherry trees. The adult or their larvae are seldom seen, but brown frass and gum appear on the trunk from the scaffold branches down to exposed roots, due to larval feeding. Gum may also appear at

wounds and on winter-injured bark, which are entry places for the borers. Young trees may be killed. Older trees are able to survive light infestations for a few years but may also weaken and die unless borers are controlled.

Adults are wasp-like moths that lay eggs around the base of the trunk in late summer and early fall. Caterpillars, 2.5-3.0 cm long with brownish heads, hatch and burrow into the wood.

❖ **TREATMENT**

Cultural control: Wrap strong paper — not tarpaper — around the trunk of young, transplanted trees up to the lowest branch, and leave in place for at least two years after planting. Any pruning or accidental wounds should be scraped clean. If the tree is infested, remove gum and poke flexible wire into the holes to kill borers. Sterilize the hole with a solution of 1 part bleach in 4 parts water and seal with putty. Do this in the spring and fall.

Chemical control: For established trees, spray bark of trunk and scaffold branches thoroughly, avoiding fruit and leaves as much as possible, beginning 10 days after petal fall, repeating three weeks later and again three weeks after second application. Correct timing is important, since only the adult can be controlled. When spraying, wear a long-sleeved shirt and pants; wash face and hands afterwards.

Recommended products: endosulfan, lindane (spray)

BACTERIAL SPOT

Bacterial spot causes small, round, tan spots to appear on leaves which later turn purplish and angular. For a full discussion, see Apricots, pg. 77.

BROWN ROT

Brown rot is a fungus that attacks various parts of the tree. For a full discussion, see Apricots, pg. 77.

Pear

CODLING MOTHS

Codling moths lay eggs in the pear fruit, and the larvae enter and grow inside. For a full discussion, see Apple, pg. 74.

BLACK ROT AND FROG-EYE LEAF SPOT

These diseases are caused by a fungus, and often occur on unsprayed trees in late summer just before the fruit matures. For a full discussion, see Apple, pg. 74.

FIRE BLIGHT

Fire blight, caused by bacteria, is most serious on pears and occasionally affects apples. Blossoms are usually first to be infected and turn black and shrivel. The disease spreads to spurs and leaves, and young twigs turn black later in the summer. Sunken reddish-brown bark lesions that ooze an orange-brown liquid may appear on larger branches. Warm weather and high humidity or rain favour the spread of this disease. If blossoms are infected, bees and other pollinators spread the bacteria to blooms on healthy shoots or trees.

❖ **TREATMENT**

Cultural control: Remove and destroy twigs 25 cm below the affected part. If pruning shears are used, dip blades in a solution of 1 part chlorine bleach to 4 parts water after each cut. Avoid heavy application of nitrogen fertilizer. Abandoned pear trees and rosaceous ornamental plants will harbour this disease.

Chemical control: None

SCAB

Scab is the most common and serious disease of apples throughout Ontario, but it can also affect pears, especially the variety Flemish Beauty. For a full discussion, see Apple, pg. 75.

PEAR LEAF BLISTER MITES

Pear leaf blister mites cause blisters and dark, dead spots on the leaves of pear. If severe, the tree may be weakened.

Pear leaf blister mite injury on apple

❖ **TREATMENT**

Cultural control: None

Chemical control: Spray before leaf buds break if this insect caused severe damage to leaves in the previous year.

Recommended product: lime sulphur, (dormant oil is not effective)

PEAR PSYLLA

The most obvious symptom of pear psylla is the honeydew that surrounds the insect on the leaf. Later, the honeydew turns black and sooty. Hot weather before and during the blossom period favours heavy infestations. If severe, leaves turn pale with dead areas, fruit is dwarfed and trees are weakened. The honeydew may also be found in late summer, as there are several generations.

The adults are reddish-brown, emerging in early spring to lay eggs on twigs. Both the adults and larvae feed by sucking the sap.

❖ **TREATMENT**

Cultural Control: None

Chemical control: Spray when honeydew is noticed and repeat at 12 day intervals.

A dormant spray at the half-inch green stage reduces psylla infestation. See pag. 91 for flowering stages.

Recommended products: dormant oil, carbaryl, insecticidal soap, permethrin, phosalone*, phosmet*

Caution: If applying dormant oil for scale control, do not use for psylla control.

PEAR SLUGS

Pear slugs are the larvae of sawflies and are not true slugs. The slime-covered larva is 1 cm long, dark green at first and later orange. It feeds on leaves of pear, cherry and plum, creating large ragged holes or leaving only a framework of veins. Telltale slime trails are also present.

❖ **TREATMENT**

Cultural control: Dust larvae with talc or dry, fine soil to dry them out.

Chemical control: Any insecticide used during the summer against other fruit insects also controls pear slugs.

Recommended product: insecticidal soap

Pear slug larvae on Prunus leaf; note skeletonization injury.

Plum And Prune

APPLE MAGGOTS OR RAILROAD WORMS

Italian and Stanley plums are susceptible to apple maggots, whereas other plum varieties are not. For a full discussion, see Apples, pg. 75.

TENTIFORM LEAFMINERS

Adult tentiform leafminers are tiny (3-4 mm long), brown and white moths. The larvae damage the leaves, creating speckled blotches of hollowed out, tented tissue. For a full discussion, see Apples, pg. 75.

* Only available in multipurpose mixtures

** See "Resistance to benomyl" pg. 25

PEAR SLUGS

Pear slugs are the larvae of sawflies and are not true slugs. For a full discussion, see Pears, pg. 84.

PEACH TREE BORERS

Peach tree borers sometimes attack plum trees. For a full discussion, see Peaches, pg. 82.

BACTERIAL SPOT

Bacterial spot causes small, round, tan spots to appear on leaves which later turn purplish and angular. For a full discussion, see Apricots, pg. 77.

BROWN ROT

Brown rot is a fungus that attacks various parts of the tree. For a full discussion, see Apricots, pg. 77.

BLACK KNOT

Black knot affects plum and sometimes cherry. It causes hard, black swellings up to 10 cm long on branches and small twigs, eventually girdling and killing the branches.

❖ **TREATMENT**

Cultural control: Remove and burn all knots when pruning or as soon as noticed, since early pruning will minimize spread. Make the cut at least 10 cm below the knot. Destroy nearby wild or neglected plum and cherry trees.

Chemical control: Spray when leaf buds start to break.

Recommended product: lime sulphur

Black knot on plum

Raspberry

ANTHRACNOSE

Anthracnose mainly affects canes, causing numerous grey spots with purple borders. Bark may crack during winter and canes will dry out and break readily during fruiting. If severe, it can affect branches, fruit stems and leaves. Immature fruit may turn brown and dry up, while ripe berries become soft and misshapen.

Anthracnose on raspberry canes

❖ **TREATMENT**

Cultural control: Promote air circulation. Cut old canes and severely affected young canes at ground level as soon as harvest is completed. Thin remaining canes to 15 cm apart and the row to no wider than 30-50 cm. Destroy all cut canes. Keep rows free from weeds.

Chemical control: Spray lime sulphur when leaf buds are breaking in spring and again when leaflets are 0.5-1 cm long. Then spray captan when the new shoots are 15-20 cm tall, again when they are 30-40 cm tall, and repeat two weeks later. Spray plants thoroughly.

Recommended products: lime sulphur, captan

APHIDS

Aphids are soft-bodied, greenish to brown, 5mm, pear-shaped insects.

They sometimes infest raspberry plants.

❖ **TREATMENT**

Cultural control: Syrphids, ladybugs and lacewings

are good natural predators of aphids and often will keep populations below damaging levels. Spray water with force to wash aphids from developing new growth.

Chemical control: Spray if these insects are abundant, but not during bloom. Observe the product's no-spray interval before harvest.

Recommended products: insecticidal soap, malathion

CANE BORER BEETLES

In June and July, cane borer beetles fly from wild or neglected raspberries or roses to attack cultivated raspberries. The female is a black and yellow long-horned beetle with two black dots on a yellow thorax. It cuts a double row of punctures about 1.25 cm apart around the raspberry stem near the tip and lays an egg between the girdles. The tip wilts and the larva bores down into the cane about 5 cm where it hibernates. The following season it continues downward and pupates. The cane dies.

❖ TREATMENT

Cultural control: Cut out and destroy wilting tips as soon as they appear. Make the cut about 15 cm below the girdles. Cut out wilted or dead fruiting canes. Destroy wild and neglected raspberries in the immediate vicinity.

Chemical control: None

Raspberry cane borer injury

RASPBERRY CROWN BORERS

Raspberry crown borers are 2.5 cm long, cream-coloured larvae with brown heads. They burrow at the base of the cane, in larger roots and crown. Affected canes wither and die, or growth is limited and fruit is small. The adult is a clear-winged moth with a wingspan of 2.5-3.0 cm. The yellow bands across its black abdomen make it resemble a yellow jacket wasp.

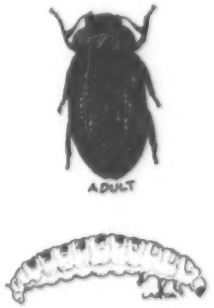
❖ TREATMENT

Cultural control: If boring is seen above ground, probe the holes with a sharp knife to kill larvae. Remove more severe infestations in late September to early October after all the eggs have been laid. Burn affected canes, including large roots, and plow under the soil. Remove any neighbouring wild raspberry canes.

Chemical control: A slight infestation (less than 5% of canes affected) may be treated in the fall and spring for two years with a drench to the crown area.

Recommended product: diazinon

FRUITWORMS



The 4 mm brown fruitworm beetles skeletonize young unfolding leaves, destroy blossom clusters and eat holes in buds. Small 6 mm larvae feed inside buds and developing fruit.

❖ TREATMENT

Cultural control: None

Chemical control: If this insect has been a problem in past years or if injury is noticed, spray or dust just before bloom. Do not apply malathion during bloom to protect bees.

Recommended products: malathion, rotenone

FRUIT ROT

Fruit rot may be a problem if rainy weather prevails between blossoming and harvest. Dark grey, black or olive-green moulds occur particularly on ripe berries.

* *Only available in multipurpose mixtures*

** *See "Resistance to benomyl" pg. 25*

❖ **TREATMENT**

Cultural control: None

Chemical control: Spray between blossoming and harvest if fruit rot was a problem in previous years and weather is wet. Repeat at 10 day intervals. Observe the product's no-spray interval before harvest.

Recommended products: benomyl**, captan

POWDERY MILDEW

Powdery mildew may occur during hot, humid weather. It appears as a white, powdery fungal growth on leaves at the tips of new shoots and on the berries. It causes stunting of young canes and distortion of leaves.

❖ **TREATMENT**

Cultural control: Reduce shading and improve air circulation around the planting. Prune to keep rows narrow (30 – 50 cm) and canes spaced 15 cm apart.

Chemical control: Spray when noticed and repeat weekly until symptoms disappear.

Recommended product: benomyl**

RUST DISEASES

Three rust diseases commonly affect raspberries and blackberries: yellow rust and late yellow rust occur on red raspberries; late yellow rust affects purple raspberries; and orange rust occurs on blackberries.

There are many symptoms of yellow rust and late yellow rust. Clumps of orange-yellow spores develop on the undersurface of leaves and occasionally on the fruit; leaves turn yellow, develop brown areas, and may drop prematurely. Severe premature leaf drop will predispose canes to winter injury. Yellow rust can also infect canes, causing overwintering lesions to become cankerous, and fruiting canes to break or dry the following summer. Yellow rust and late yellow rust fungi overwinter in infected tissues.

Blackberries infected with orange rust develop upright, spindly shoots. In the spring, a yellow coating develops on the undersurface of developing leaves, leaving them dwarfed and misshapen. This coating later breaks open to reveal bright orange spores, which spread the disease.

❖ **TREATMENT**

Cultural control: Orange rust overwinters in the canes, crowns and roots of diseased plants. Diseased plants do not recover and should be dug up and removed when noticed.

Yellow rust and late yellow rust are of minor importance in Ontario, causing problems only in years with late spring rains and cool, humid weather. Remove and discard infected canes and leaves in fall or early spring to reduce the spread of the disease.

Chemical control: Where susceptible varieties are severely attacked, apply dormant application of lime sulphur.

Recommended product: lime sulphur

RASPBERRY SAWFLIES

Larvae of raspberry sawflies are pale green and about 1 cm long when full grown. Their damage can be seen by late May or early June. Large irregular holes appear in leaves and all but the larger veins of the leaf can be destroyed. The damage is usually not harmful.

❖ **TREATMENT**

Cultural control: None

Chemical control: Treat leaves if new cane growth is severely damaged.

Recommended products: insecticidal soap, rotenone

Raspberry sawfly injury

SAP BEETLES

Sap beetles, also called picnic beetles, are 6 mm long and black with cream markings. They attack raspberries, tomatoes and sweet corn. They bore into berries when almost ripe, and may also invade picked berries. Large numbers make them very difficult to remove by hand.

❖ **TREATMENT**

Cultural control: Remove picked fruit from the planting promptly. Use bait of mashed bananas, ripe melon, or chopped immature sweet corn placed in open containers in several places between plantings; renew regularly and destroy the beetles that have been trapped. Apple cider vinegar or a mixture of yeast, sugar and water combined with a few drops of liquid detergent will drown the beetles.

Chemical control: Commercially prepared bait is available.

Recommended product: carbaryl (bait)

SPUR BLIGHT

Spur blight is most serious on the lower part of first-year canes where purplish-brown areas appear around joints of leaf stems and canes. On second-year canes, diseased areas are grey with small black pimples. Canes are weakened and may be killed during winter. Buds in affected areas produce weak branches and the leaves turn yellow and brown when berries are ripening.

❖ **TREATMENT**

Cultural control: Promote air circulation. Cut old canes and severely affected young canes at ground level as soon as harvest is completed. Thin remaining canes to about 15 cm apart and the row no wider than 30-50 cm. Destroy all cut canes. Keep rows free from weeds.

Chemical control: Spray lime sulphur when leaf buds are breaking in spring and again when leaflets are 0.5-1 cm long. Then spray captan when the new shoots are 15-20 cm tall, again when they are 30-40 cm tall, and repeat two weeks later. Spray thoroughly.

Recommended products: lime sulphur, captan

Spur blight on raspberry canes

VIRUSES

Viruses cause poor plant vigour, low yields, short-lived plantings and crumbly berries. Leaves may be mottled, puckered and curled. Affected plants are most visible in June. Most viruses of raspberries are spread by aphids.

❖ **TREATMENT**

Cultural control: Spray water with force to wash aphids from developing new growth. Remove and destroy all infected plants. Replant with culture-indexed stock.

Chemical control: Spray if severe but not during bloom. Observe the no-spray interval before harvest as stated on the product label.

Recommended products: insecticidal soap, malathion

Strawberry

BLACK ROOT ROT

Black root rot is a soil borne disease causing roots of old plants to turn dark brown with no feeder roots present. The outer root covering peels off easily.

❖ **TREATMENT**

Cultural control: Avoid heavy, poorly drained soils with high water tables to prevent roots from becoming waterlogged or frozen. Use certified plants to reduce the risk of introducing root diseases and viruses into the garden.

Chemical control: None

FRUIT ROT OR GREY MOULD

Fruit rot, also called grey mould, is common during wet weather between blossoming and harvest. Berries

rot when almost ripe, although green fruit may also be infected. Control is difficult when disease is established; prevention is more effective.

❖ **TREATMENT**

Cultural control: Protect blossoms from frost injury with straw mulch. Remove infected berries from fruit clusters when observed. If irrigation is necessary, water thoroughly in the morning to allow time to dry before evening. Pick all fruit at the end of harvest to reduce the incidence the following year.

Chemical control: Start spraying just before first blossoms open, and repeat at weekly intervals. Benomyl may be applied until the end of the harvest.

Recommended products: benomyl**, captan

Caution: Do not apply captan later than the end of the blossoming period.

LEAF SPOT

Leaf spot disease causes red-purple spots on leaves of first- and second-year plants. Spots enlarge and centres become grey. If spots are numerous, leaves may be killed and yield reduced.

❖ **TREATMENT**

Cultural control: Trim off diseased leaves when planting.

Chemical control: Spray one month after planting and repeat twice at 14 day intervals.

Recommended product: captan

PLANT BUGS

Plant bugs pierce flower clusters and developing fruit, sucking the sap and causing small deformed berries. Adult tarnished plant bugs (TPB) are brown, while the four-lined plant bugs (FLPB) are greenish-yellow with four black stripes. Both are triangular in front, 6-7 mm long and about half as wide. They are very active, readily flying when disturbed. Young TPB are light green, while young FLPB are bright red, each with dark spots and markings. The TPB can be a problem throughout the season, while FLPB is prevalent in late spring and summer.

❖ **TREATMENT**

Cultural control: Follow proper garden sanitation practices in fall and spring.

Chemical control: If there has been a problem in the past, spray just before blossoms open and again about 10 days later. If many blossoms have opened, spray during late evening to avoid killing bees.

Recommended product: dimethoate

RED STELE

Red Stele is a common root rot disease causing the inner roots to turn rusty red in April-May and September-October and have a rat-tailed appearance. Plants are stunted because roots function poorly and berries are small though not deformed.

❖ **TREATMENT**

Cultural control: Where this disease is a problem, obtain certified young plants with cream-coloured roots every year and harvest during the following year only. Since this is primarily a disease of older plants, remove old plantings after harvest. Improve soil drainage and avoid soil compaction. Plant in a different location where space permits.

Chemical control: None

SLUGS

Slugs are tear-drop shaped, slimy and legless and create small to moderate holes in fruit and leaves, leaving telltale glistening trails. Damp rainy weather and mulches favour slugs.

❖ **TREATMENT**

Cultural control: Remove materials that would provide daytime hiding sites such as plant debris, rocks, boards and logs. Promote air movement by thinning plants. Place shallow dishes of beer or juice as bait and replace frequently. Set out traps of 15 cm square boards and handpick slugs from the boards.

Chemical control: When injury is noticed, place bait in small amounts on soil at 1 m intervals; cover with boards or bricks. Keep bait moist.

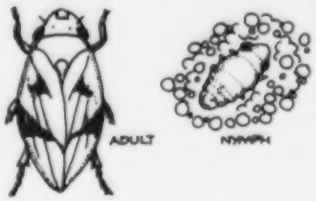
* Only available in multipurpose mixtures

** See "Resistance to benomyl" pg. 25

Recommended product: metaldehyde

Caution: Bait is attractive and very poisonous to dogs and birds. Do not apply bait on edible parts of plants.

SPITTLEBUGS



Spittlebugs are sap-sucking insects. In their immature stages, they cover themselves with a frothy saliva-like protective mass. The adults are brown and inconspicuous, and they jump easily when disturbed. Stunting and distorting of the new growth are the most common signs of damage. They are present in May and early June with usually one generation per season.

❖ **TREATMENT**

Cultural control: Pick off and destroy.

Chemical control: None

STRAWBERRY CLIPPER WEEVILS

Strawberry clipper weevils are destructive, 2-3 mm long beetles with reddish snouts. They cut the stems of blossom buds, causing them to wilt and drop off or to hang by a thread. Observe strawberry buds closely, and spray when first clipped buds are noticed.

❖ **TREATMENT**

Cultural control: None

Chemical control: If many blossoms have opened, spray in the evening to avoid killing bees.

Recommended product: methoxychlor

STRAWBERRY LEAFROLLERS

Strawberry leafrollers are small, greenish or bronze 1.25 cm long caterpillars that fold or roll leaflets with fine silken threads. Overwintering as pupae, small greyish or brown moths emerge in mid-to-late May to lay eggs on the undersurface of the leaves. The larvae migrate to the upper leaf surface when half-grown, roll the leaves for protection and continue feeding. A second generation occurs in mid-August.

❖ **TREATMENT**

Cultural control: If infection is minor, remove affected leaves and destroy.

Chemical control: If past damage has been severe, apply insecticide using sufficient water to thoroughly wet plants during the first or second week of June and again during the third week of August.

Recommended product: malathion

Strawberry leafroller injury

WHITE GRUBS AND WIREWORMS

White grubs are young June beetle or Japanese beetle, or European chafer. They are plump, white larvae with brown heads. Wireworms are orange, hard-bodied larvae with six legs. They both may cause extensive damage to new strawberry plantings as the larvae feed on the roots. Usually plants collapse during the fruit-sizing period. They are often present in new gardens when sod is converted to garden.

❖ **TREATMENT**

Cultural control: If the area to be planted is in grass sod, till or dig the soil before mid-May and delay planting until the following year. During the fallow year, cultivate the area regularly, or plant the area with a crucifer crop (cabbage, broccoli, cauliflower, kale, Brussels sprouts, kohlrabi) or snap beans, as roots of these plants are not favoured by white grubs or wireworms.

Chemical control: None

FIGURE C: Flowering Stages on Fruit

DORMANT HALF-INCH GREEN PINK PETAL FALL

** With permission of the Michigan State Cooperative Extension Service.*

TABLE 10: Spray Program for Apple and Pear

TIME TO SPRAY	PESTS TO CONTROL	PESTICIDES TO USE	REMARKS
Dormant stage before buds break	Scale insects	Dormant oil spray	Apply dormant oil in the morning to allow thorough drying before a cold night. Dormant oil may injure the bark of Red Delicious apple and may enlarge lenticels of pear bark on young twigs. Use dormant strength. Use sufficient spray mixture to wet all twigs and bugs thoroughly; spray from all sides of tree.
	Pear scab on Flemish Beauty Pear	Dormant lime sulphur spray	Lime sulphur in this season eliminates pear scab fungus overwintering on twigs (e.g. on Flemish Beauty and Sheldon). If pear scab is not a serious problem, omit dormant application for scab.
Half-inch green stage	Mites	Dormant oil spray	Oil controls European red mite eggs but not two-spotted spider mite. *Caution: if dormant oil was applied for scale, do not use it for mite control.*
When buds break until open flower bud cluster	Apple scab Pear Scab	Use one of: Benomyl** Captan Ferbam** Sulphur	Sprays may be required weekly during this time if prolonged wet periods occur. Do not apply captan if dormant oil spray was applied. Do not use benomyl on pear.
From pink flower buds until first open blossoms	Apple scab Pear scab	Use one of: Benomyl** Captan Ferbam* Sulphur	Sprays may be required if prolonged wet periods occur. Do not use benomyl on pear.
	Caterpillars Pear psylla	Add one of: Carbaryl Diazinon Insecticidal soap Methoxychlor Permethrin Phosalone*	Never use insecticides when blossoms are open or dandelions are in bloom under fruit trees. If aphids become a problem, use either diazinon or phosalone. Insecticidal soap is registered for use against pear psylla and pear slugs only. Do not use methoxychlor for pear psylla.
Blossom Period	DO NOT APPLY INSECTICIDES OR MULTIPURPOSE MIXTURES DURING BLOSSOM PERIOD		A spray of captan or benomyl may be applied for scab if necessary. Do not use benomyl on pear.
When flower petals fall	Apple scab Pear scab	Use one of: Benomyl** Captan Ferbam* Sulphur	Do not use benomyl on pear.
	Mites Pear psylla Plum curculios Plant bugs	Add one of: Diazinon Dicofol* Dimethoate Insecticidal soap Permethrin Phosalone	To avoid thinning of apples (not pears), do not apply carbaryl at this time. If mites have been a serious problem, use dimethoate, phosalone or a mixture containing dicofol. Insecticidal soap is for use on pears for pear psylla and pear slugs control only.

continued on next page

* Only available in multipurpose mixtures

** See "Resistance to benomyl" pg. 25

TIME TO SPRAY	PESTS TO CONTROL	PESTICIDES TO USE	REMARKS
12 days after petal fall and repeat at 12 to 14 day intervals until mid-August	Scab	Use one of: Benomyl** Captan Ferbam* Sulphur	Observe no-spray interval before harvest as stated on product label. Do not use benomyl on pear.
	Pear psylla Curculios Apple maggots Codling moths Plant bugs	Add one of: Carbaryl Diazinon Dimethoate Insecticidal soap Permethrin Phosalone*	Unless fruit set on apple is very heavy, do not use carbaryl insecticide within 3 weeks after petal fall. Insecticidal soap is registered for use against pear psylla and pear slugs only. Apple maggots are very difficult to control if unsprayed apple, crabapple, prune, quince or hawthorn trees grow nearby.

TABLE 11: Spray Program for Apricot, Cherry, Nectarine, Peach and Plum

TIME TO SPRAY	PESTS TO CONTROL	PESTICIDES TO USE	REMARKS
Dormant stage before buds break	Scale insects	Use one of: Dormant oil spray Dormant lime sulphur	Spray dormant oil in the morning to allow thorough drying before a cold night. Use dormant strength.
	Peach leaf curl	Use one of: Lime sulphur Ferbam	For peach and nectarine trees, one peach leaf curl spray is usually needed every year.
	Plum black knot	Lime sulphur	Delay spray until buds are about to burst. Injury will occur if too late or if spray dries slowly. Cutting out the knots is the important control. The lime sulphur will not prevent an outbreak of mites.
Half-inch green stage	Mites	Dormant oil spray	Oil controls European red mite eggs but not two-spotted spider mite. *Caution: If dormant oil was applied for scale, do not use it for mite control.*
When flower petals fall	Plum leaf spot Cherry leaf spot	Use one of: Benomyl** Captan Ferbam* Sulphur	Spray immediately when petals start to fall. If leaf spot has been serious on plum and cherry, use captan or ferbam. Leaf spot fungus does not affect peach and nectarine. Do not use sulphur on cherry.
	Plum curculios on plum, cherry, peach	Add one of: Carbaryl Diazinon Permethrin Phosalone*	Time to spray as above. These may be combined with the fungicides above. If plum curculios are not a problem, omit the insecticide. Plum curculio injury may increase brown rot of stone fruit.
Ten days later	Plum leaf spot Cherry leaf spot Plum curculios	Same as above	

continued on next page

* Only available in multipurpose mixtures

** See "Resistance to benomyl" pg. 25

TIME TO SPRAY	PESTS TO CONTROL	PESTICIDES TO USE	REMARKS
July 1-10	Leaf spot Brown rot	Use one of: Benomyl** Captan Ferbam* Sulphur	Dates for this and following sprays are only approximate, depending on geographic location and season. Do not use sulphur on cherry.
	Cherry maggots Fruit moths Worms in peach	Use one of: Carbaryl Diazinon Dimethoate Permethrin Phosalone*	Where cherry maggots have been a problem in the previous year, also spray 10 days earlier (June 20-30). Do not use diazinon on peach. Dimethoate may only be used on sweet and sour cherries.
July 15-30	Leaf spot Brown rot	Use one of: Benomyl** Captan Ferbam* Sulphur	Observe no-spray interval before harvest as stated on the product label.
	Worms in peach Maggots in prune Mites	Use one of: Carbaryl Diazinon Dimethoate Permethrin Phosalone*	Check foliage at this time for mite injury.
Later sprays	Leaf spot Brown rot	Use one of: Benomyl** Captan Ferbam* Sulphur	Observe no-spray interval before harvest as stated on the product label. On cherry, apply only fungicide for leaf spot after harvest. Plums and peaches may require an extra spray for brown rot before harvest.
	Worms in peach	Use one of: Carbaryl Diazinon Dimethoate Permethrin Phosalone*	Late peaches may require an insecticide about 4 weeks before picking.

Cherry

* Only available in multipurpose mixtures

** See "Resistance to benomyl" pg. 25

• 7 •

ORNAMENTAL PLANTS

PROBLEM AREAS ON ORNAMENTAL PLANTS

Use the following information as a guide when identifying the cause of your plant problems. Examine the damage on the plant and then refer to the corresponding section. Remember, however, that similar symptoms can result from different problems. When in doubt, consult a qualified specialist.

Seedlings and Transplants

Seedlings don't emerge, are stunted or wilt early

- seed has lost viability
- unfavourable soil conditions: too cold, too wet, too dry, compacted or with surface crusting
- improper planting depth
- damping-off disease, seed-borne fungal disease, bacterial disease
- seed corn maggots, wireworms or similar insects
- exposure to pre-emergence herbicides or to excessive fertilizer salts

Seedlings are cut off near the ground, or are badly chewed

- insect and pest damage: cutworms or earwigs; slugs or snails; sowbugs or pill bugs
- animal damage: birds feeding on seeds or seedlings; meadow mice, chipmunks, groundhogs, rabbits

Transplants wilt, develop dead areas on leaves or die

- stems or roots damaged during transplanting; transplant shock
- transplants diseased at the start
- abiotic causes: over-fertiliza-

tion; soil too wet or too dry; cold temperature or frost; transplants planted too deeply
- damping-off and root rot fungi
- insects such as white grubs or wireworms

Leaves or Needles

Dead spots on leaves
- fungus leaf spot, blight, anthracnose, Botrytis, white mould, black spot (roses)
- bacterial leaf spot or blight
- injury from contact-type weed killers (paraquat) applied nearby

Scorched or browned leaf margins or interveinal areas
- abiotic causes: severe temperature changes; soil too wet or too dry; over-fertilization; herbicide damage; salt injury; mechanical injury to root or stem
- root rot
- insect or nematode damage
- feeding damage by mites or insects such as leafhoppers or thrips

Deformed leaves
- herbicide injury, most often from lawn weed-killers
- viral disease
- frost or severe wind injury
- infestation of aphids, leafhoppers or plant bugs

Abnormal growths on leaves
- leaf curl or blister fungi
- gall-forming insects, mites, or other organisms
- edema or tan blistering

Grainy material or insect larva found in dead, hollowed out areas on leaves
- leafmining insects; birch cedar leafminer

Small notches at leaf margins or lace-like skeleton leaves
- leaf skeletonizer insects: pear or rose slug; elm or willow leaf beetle
- young or small insects such as caterpillars and beetles
- black-vine weevil; Taxus weevil

Sections of leaf completely missing, with ragged or clean-cut edges
- caterpillars, cutworms, grasshoppers, leaf beetle, leaf cutter bees or ants
- slugs or snails
- groundhogs, rabbits, deer, etc.
- severe wind injury or hail

Sticky deposit on leaves, can be sooty and black
- sucking insects: aphids, mealybug, scale and whitefly

Yellowed leaves
- abiotic causes: improper pH, nutrient deficiency, too wet or too dry, over-fertilization, herbicide injury from residues in soil
- root rot
- nematode infestation of roots
- wilt disease, either bacterial or fungal
- autumn shed of conifers

Bleached, bronzed or glazed leaves
- abiotic causes: chilling injury, sun scald, desiccation by strong winds, air pollution, damage by dogs
- mites, thrips or lacebugs

Red or purple leaves
- abiotic causes: nutrient deficiency in soil (usually phosphorus) or high pH (alkaline), cold temperature stress
- poor root growth
- needle cast of spruce

Mottled yellow and green leaves
- virus, fungus or mycoplasma-like organism
- plant bugs, leafhoppers or other leaf insects

Premature fall colouring
- unfavourable soil conditions
- damaged root systems
- trees in state of decline

Mould on leaves
- olive-green, black or dark brown: scab
- sticky black: sooty mould
- greyish-brown: Botrytis
- white and fluffy: white mould
- white and powdery: powdery mildew
- rusty red or orange blisters: rust
- shiny black: tar spot

Fine webbing on leaves
- mites

Leaves rolled up or covered with silk webbing containing frass
- tent caterpillars, fall webworm, ugly nest caterpillar, leafroller caterpillars, web spinning sawflies

Stem, Trunk or Branches

Sunken areas of dead bark; bark missing or cracking
- cankers caused by fungi or bacteria
- cankers caused by abiotic injury: winter injury, lightning, vandalism, power tools
- animal damage: squirrels, porcupines, meadow mice, rabbits

Gum, resin, or sawdust-like frass on bark; ridging on bark
- wood-boring insects
- canker fungi or bacteria
- mechanical wound
- winter injury

Swellings on bark
- crown gall
- cedar apple or quince rust on juniper
- fungus gall (Black Knot)
- feeding or egg-laying by insects

Branches, twigs, or leaves with bumps that easily scrape off

- scale

Branches and leaves rolled up or covered with silk webbing containing frass

- scale insects, tent caterpillars, fall webworm, ugly nest caterpillar, leafroller caterpillars, web spinning sawflies

Inner tissues of branch, stem, or trunk show discoloration or decay

- outer wood (sapwood) discoloured: fungal wilt disease, fire blight, bacterial blight, wood decay fungus
- inner wood discoloured (fungi or mushrooms may be on bark or on ground nearby): winter injury or *Armillaria* root rot
- discoloured stems on herbaceous plants: bacterial or fungal wilt disease

Branches die back from tips

- shoot-boring insects
- tip blight fungus or bacterial blight
- winter injury

Throughout Plant

Plants wilt or die suddenly

- abiotic causes: over-fertilization, exposure to high soluble salts, severe drought, root girdling, winter injury
- black walnut trees nearby
- insects boring or tunnelling in stem
- wilt or canker fungi or bacteria attacking roots and stem
- root rot disease

Slow growth; sections die back; discoloration; premature fall colour

- abiotic causes: winter injury, improper soil moisture, exposure to herbicides, salt injury, root girdling
- root gall disease
- birch dieback, ash and maple decline
- root rot disease
- cankers or borers girdling trunk or stem
- nematode infestation

Roots or Tubers

Plant pulls out easily; discolored roots; outer root pulls away from inner

- root rot
- soil too moist
- root-feeding insects
- nematode infestation

Swellings on roots

- crown gall
- root knot or cyst nematodes
- normal root nodules on plants of the legume (pea) family

Tunnels in or on root

- black vine or Taxus weevil, white grubs
- rodents

Soft, smelly roots or rhizomes

- bacterial soft rot

Buds and Young Shoots

Buds are dead, dry, or discoloured

- abiotic causes: winter injury, stress during previous year caused poor bud set, salt spray from nearby road

Misshapen or swollen buds

- insect or mite injury
- virus or mycoplasma disease
- herbicide injury

New shoots wilt and die

- winter kill or frost injury (delayed effect)
- fungal or bacterial blight
- shoot-boring insects
- girdling by rabbits and rodents

Flowers

Flowers do not appear

- flower buds not produced the previous year
- flower buds removed by pruning
- winter kill or frost injury to buds

Flowers die without producing fruit

- winter or frost injury
- fungal or bacterial disease such as Botrytis, leaf spots and fire blight
- poor pollination

Misshapen flowers

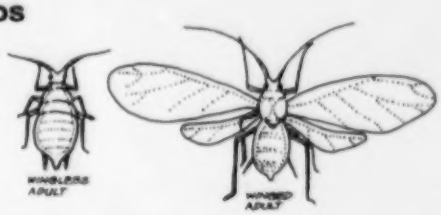
- aphids, plant bugs or thrips
- virus disease
- aster yellows

Flowers eaten inside or on petals

- aphids, corn rootworm beetles, earwigs, grasshoppers, rose chafer, Japanese beetle, thrips
- slugs or snails

INSECT CONTROL ON ORNAMENTAL PLANTS

APHIDS



Aphids or plant lice are small soft-bodied pear-shaped insects. Colours range from green to red, brown or black. They weaken the host plant by sucking its sap, usually at the tips of shoots and on the underside of young branches. Infested leaves often become cupped and misshapen. Many species also leave a sticky deposit called honeydew on the plant, which encourages the development of black sooty mould. Most aphid species have several generations per growing season.

Many plants are susceptible to aphid infestations, especially birch, chrysanthemum, flowering cherry, crabapple, honeysuckle, Norway maple, linden, rose, spirea, snowball viburnum, willow and flowering annuals.

The honeysuckle aphid is a 2 mm long, pale green to cream coloured aphid, with a fine powdery wax covering its body. It attacks the honeysuckle plant, causing stunted growth, witches brooming, and curling of the pale green leaves. The honeysuckle aphid overwinters as eggs on the twigs, hatching in the spring at bud break. Early control is recommended.

❖ TREATMENT

Cultural control: To control the honeysuckle aphid, prune out infested branches well below the witches broom, before the buds begin to break in the spring. You should also consider applying dormant oil at this time. If possible, replace susceptible varieties with more resistant strains.

Chemical control: Spray or dust flowering annuals and shrubs when aphids are first noticed and repeat as required. When plants are in flower apply insecticide only in the evening when bees are not present. Do not use malathion on Crimson King maple. If chemical control is necessary on large trees, tree maintenance companies have suitable application equipment.

Recommended products: carbaryl, chlorpyrifos, diazinon, insecticidal soap , malathion, oxydemeton-methyl*, permethrin, pirimicarb*

BARK BEETLES

Bark beetles bore into the trunks or branches of trees and deposit their eggs. Once hatched, the larvae feed on the wood, creating vertical or horizontal tunnels eventually girdling the stem. Pupation also occurs under the bark, and the adults tunnel out to move to a new site.

Bark beetles are attracted to old trees or trees weakened by transplanting shock, mechanical injury or poor soil conditions. Pine, spruce, eastern white cedar, eastern red cedar, linden, maple, hawthorn, ornamental cherries and mountain ash are most susceptible.

Thinning and dying back of leaves and the presence of wood dust are the first signs of a problem. Closer inspection reveals small holes about 2 mm in diameter on the trunk and branches. Tunnels of the ambrosia beetle are also covered with a black fungal stain.

❖ TREATMENT

Cultural control: Transplant trees should be placed in well-prepared soil, and established trees should be protected from abiotic injury, especially to their bark. A proper fertilization program will also improve the tree's vigour by reducing competition with surrounding turf. Remove and destroy all infested trees and shrubs.

Chemical control: None

BIRCH LEAFMINERS

In mid-May and again in early July, small black sawflies emerge from the soil and lay eggs on leaves. Larvae hatch and soon enter leaf tissue where they are protected against insecticides. The injury shows as large brown blotches on leaves. Badly mined leaves turn yellow and fall in mid-summer. This problem is very common on birch trees, particularly the European white birch.

❖ TREATMENT

Cultural control: None

Chemical control: Treatments can be applied as a bark treatment, soil drench or foliar spray. Foliar

sprays are not practical for larger trees. Symptoms appear on trees when Spirea vanhouttei blooms.

Recommended products: Dimethoate is the principal chemical control. Others include carbaryl, malathion and oxydementon-methyl*.

BLACK VINE WEEVILS, TAXUS WEEVILS AND STRAWBERRY ROOT WEEVILS

see Plate 29

Black vine or Taxus weevils are non-flying black snout beetles 9-13 mm long. The adult black vine weevil feeds at night, making notches on edges of needles or leaves. By day, it hides in dark places under litter or mulch. The weevil is an insidious pest because the most serious damage is done by the larvae, and occurs below the soil surface. Azalea, Euonymus, hemlock, rhododendron, yew and eastern white cedar are most susceptible to black vine weevil.

The strawberry root weevil adult is a dark brown, slightly smaller (6 mm) non-flying insect that is a more common problem on herbaceous ornamentals, eastern white cedar, spruce and juniper. The adults feed at night on leaves and needles.

The weevil grubs, about 1 cm in length, have white, legless, C-shaped bodies with brown heads. They can be found at a depth of 2-25 cm around the roots. They feed on the fibrous roots and strip the bark off the larger roots, causing the plants to grow poorly, dry out and loose colour, resulting in eventual death.

❖ TREATMENT

Cultural control: Place burlap under infested shrubs to trap adults who will use it as a place to hide during the day.

Chemical control: When injury is noticed, spray the trunk, lower branches and soil surface. Spray in late June and again in early July. Spray in the evening as adult activity begins after sunset.

Recommended products: carbaryl (Sanex liquid Sevin), endosulfan. Do not apply endosulfan on Anderson yew as needles may drop.

BORERS

Borer larvae tunnel into wood. Over the years, they can weaken and kill a plant. Signs of infestation include holes in the wood with sawdust underneath or gummy substance on ornamental cherry, plum and peach trees. Young trees, especially those recently transplanted, are very susceptible to attack by borers. Weak or old plants are also vulnerable.

❖ TREATMENT

Cultural control: Protect young or transplanted trees by wrapping strong paper or burlap around the trunk from ground level to the lowest branch. Do not use tar paper as the fumes may be injurious. Continue wrapping for at least two years after transplanting. This method is not practical for shrubs. Instead, borer-infested stems should be removed.

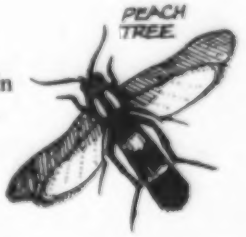
Remove any grass sod from around the trunk, either by herbicides or mechanically, and provide a thick layer of mulch, adequate fertilizer and water to promote healthy growth.

When planting a white birch, provide mulch 1 m in diameter around the base of the tree and continue to enlarge as tree grows to reduce stress. Wounds in the bark make it easier for the small borer larvae to enter. Avoid wounding with tools or lawn mowers. Scrape any wounds clean. If borers are already tunnelling in the tree, poke a flexible wire into each hole, then seal with putty or similar substance. Do this in early spring and again in fall.

Chemical control: Thoroughly spray the bark of main branches and trunk to ground level. It is important to spray at the correct time for each kind of plant, as different species of borers are involved and young larvae have to be killed before they enter the wood. When spraying wear long-sleeved shirt and pants; wash face and hands afterwards.

Recommended products: endosulfan, lindane (spray)

Ash, lilac, mountain ash, privet: Each have a specific borer that attacks them. Spray in mid-May, repeat in late May and early June. Allow 10 days between sprays.



Flowering cherry, peach and plum: Attacked by peach tree borer. Spray in late June, repeat in mid-July and early August. Allow three weeks between sprays.

Black locust: Attacked by locust borer. Spray in mid-August, repeat in early and late September.

Poplar and willow: Attacked by poplar and willow borer. Spray in mid-August and again in early September.

Azalea, laurel, rhododendron: Attacked by rhododendron borer. Spray about May 20 and again June 15.

For **Iris Borer** see pg. 105.

BIRCH DIEBACK (Birch Borers)

Birch trees under stress attract bronze birch borers, which in turn can lead to dieback fungi. This is particularly true of the European birch tree, which is relatively short-lived (15-30 years) and shallow-rooted. In home gardens, it often grows under conditions of poor soil and inadequate moisture. Once the borer enters the tree, the upper and outer branches are girdled first, causing them to die, before the main stem is affected. The elongated white larvae, which develop over two years, make long winding tunnels just under the bark, appearing as spiral ridges around the branches and trunk. Yellowed, sparse leaves are early symptoms, and the tree gradually dies from the top downward.

The adult borer is a slender, olive-bronze, 12 mm long beetle that emerges from June to August through holes in the bark and feeds on leaves.

❖ TREATMENT

Cultural control: Cut and destroy dying branches before late May. Improving the vigour of the tree will reduce the risk of infestation. Birch roots do not compete well with lawn grasses. Water the root zone deeply several times during the growing season. Apply control for birch leafminer (pg. 98) to reduce stress.

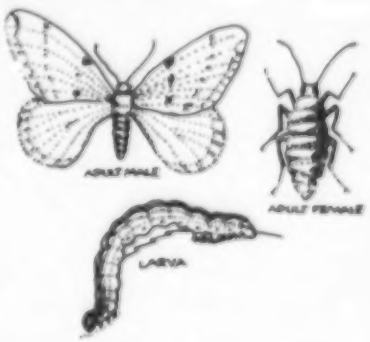
Chemical control: None

Caterpillar Family

The damage caused by insects in this family is predominantly defoliation. Larvae feed on the leaves of trees and shrubs, and if the infestation is serious and repeated over several seasons, the plant will be killed.

In most cases, however, plants can withstand considerable defoliation before they are seriously harmed. The effects of early season defoliators such as spring cankerworms, for example, are often overcome by a new burst of growth in late spring. Late season defoliators such as the fall webworm also cause little damage, because most growth, food storage, and bud production has already occurred.

CANKER WORMS, LOOPERS *see Plate 11*



Fall and spring canker worms and loopers are long, thin green caterpillars that move by extending forward and pulling the hind body up in a characteristic inchworm loop. Insects are most apparent in the spring, feeding on unfolding leaves. They are sporadic, however, and may be prevalent in one year, only to disappear for several years before again becoming a problem. The females are wingless moths; they crawl up the tree in fall or spring and lay egg masses on the bark. The insects feed on a wide range of plants including apple, oak, linden and beech.

❖ TREATMENT

Cultural control: If trees are isolated, bands of sticky material such as Tack-Trap or Stickem can be placed around the trunk in the spring and fall to trap the moths as they crawl up the tree.

Chemical control: The decision to use chemical control should be based on two factors: first, the extent of long-term damage that will occur from defoliation by caterpillars; and second, the cost of the treatment and the potential for injury to other plants from spray drift. If chemical control is indicated, spray or dust when caterpillars are first noticed. Treat when larvae appear in mid-May when Norway maple and saucer magnolia are in

bloom. Bacillus thuringiensis must be applied early in the season when caterpillars are small (0.5 cm). For loopers, treatment may have to be repeated. Do not apply endosulfan on European white birch and weeping birch as injury may occur.

Recommended products: Bacillus thuringiensis, carbaryl, diazinon, endosulfan, methoxychlor, oxydemeton-methyl*, permethrin, trichlorfon*

TENT CATERPILLARS, WEBWORMS, LEAF ROLLERS

see Plate 30

The presence of these caterpillars often goes undetected until the tell-tale webbing, tents or dropping frass appear, yet it is the defoliation that is most damaging. Birch, crabapple, flowering cherry, hawthorn, juniper, privet, and linden are common host plants but many others may also be attacked.

In the spring, the **eastern tent caterpillar** spins a silken tent in the branch forks of apple, hawthorn, flowering cherry and other deciduous trees and shrubs. The tent is for shelter, from which the caterpillars venture out during the day to feed. The caterpillars are black and hairy, with brown and yellow lines and blue spots along the sides, and a white stripe down the back.

The **forest tent caterpillar** is also hairy and black, but with blue, orange and pale yellow stripes on the sides, and white footprints along the back. It prefers ash, birch, oak, poplar and sugar maple, but also attacks a wide variety of deciduous trees and shrubs. Its tents are flat mats on the bark of trees, not in the forks of the branches, and so are less obvious than those of the eastern tent caterpillar.

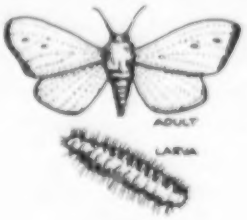
Spiny elm caterpillars are black-bodied, covered with small white flecks and spines, with a row of large red spots down the back. Preferring elm and willow, they will feed on birch, maple and several other deciduous trees, becoming obvious during mid-to-late spring.

Leafrollers are caterpillars that typically tie a leaf inwardly, feeding inside in a protected rolled up chamber. In Ontario, fruit tree leafroller and red banded leafroller attack many ornamental trees, shrubs and fruit trees. They can be controlled only if insecticides are applied in early spring before the caterpillars enter the protection of the rolled leaf.

White-marked **tussock moths** are redheaded, black and white tufted caterpillars that feed on a wide variety of deciduous and coniferous trees and shrubs, skeletonizing leaves. The larvae have reddish-orange heads and yellow bodies tufted with distinctive hair.

Satin moths, named because of their white satin sheen, are present in July and are reportedly becoming prevalent in the greater Toronto area. The brightly coloured, orange and white spotted larvae overwinter in silken cocoon-like structures, beginning to feed after leaves have developed.

Fall webworms are hairy, pale yellow caterpillars that spin large webs over branch tips of ash, birch, box elder, crabapple, cherry, linden, poplar, oak, walnut and many others in August and September.



Juniper webworms are light brown caterpillars about 12 mm long that feed at the base of juniper needles. Needles are webbed together during early fall and again the following spring.

Pine webworms are yellowish-brown larvae with two dark stripes along the length of each side. In midsummer, larval colonies feed on needles enclosed in coarse webbed frass masses on twigs and branches.

❖ TREATMENT

Cultural control: Removal or breaking of the tents exposes the caterpillars to predators and the elements. This is particularly effective on cold evenings. During periods of warm weather, twigs with tents should be pruned out and destroyed. Hand-pick light infestations of pine webworm. Tent caterpillars produce brown, hard, foam-like egg collars on twigs, which can be pruned out or removed in winter or early spring before the eggs hatch.

Chemical control: The decision to use chemical control should be based on two factors: first, the

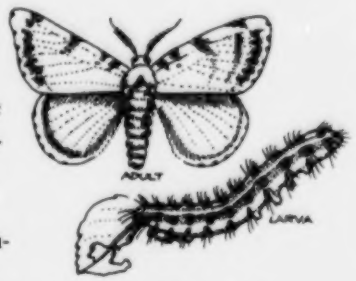
* *Only available in multipurpose mixtures*

** See "Resistance to benomyl", pg. 25

extent of long-term damage that will occur from defoliation by caterpillars; and second, the cost of the treatment and the potential for injury to other plants from spray drift. If chemical control is indicated, spray or dust when caterpillars or their tents are first noticed. Treatment for juniper webworm must be applied when larvae are active (late August and September). Treatment for tent caterpillar must be done at bud break when the eggs hatch. Bacillus thuringiensis must be applied early in the season when caterpillars are small (0.5 cm). Do not apply endosulfan on European white birch and weeping birch as injury may occur.

Recommended products: Bacillus thuringiensis, carbaryl, diazinon, endosulfan, methoxychlor, oxydemeton-methyl*, permethrin, trichlorfon*

GYPSY MOTHS



Gypsy moths are a major pest of trees and shrubs in the late spring and early summer in Ontario. The larva is a dark, hairy caterpillar with a double row of five pairs of blue and six pairs of red spots on its back. The young emerge from a buff-coloured egg-mass that was deposited the previous fall, and move or are blown to suitable host vegetation. They feed voraciously on nearly any woody plant except juniper, reaching up to 7 cm long before pupation in July. The flightless female moths lay egg masses on nearly any object. Vehicles, camping equipment and similar objects, therefore, regularly carry infestations to new regions. They consume the leaves of many trees and shrubs but prefer basswood, birch, hawthorn, oak, poplar and willow.

❖ TREATMENT

Cultural control: Before the eggs hatch, scrape gypsy moth egg masses into a container of dish detergent, which will kill eggs. Once the young have emerged, trap them by tying a band of burlap around tree trunks, and destroy any caterpillars found within. This is only practical for a small number of trees, and you must be sure to inspect the burlap daily.

Chemical control: The decision to use chemical control should be based on two factors: first, the extent of long-term damage that will occur from feeding; and second, the cost of the treatment and the potential for injury to other plants from spray drift. If chemical control is indicated, spray or dust when caterpillars are first noticed. Bacillus thuringiensis must be applied early in the season when caterpillars are small (0.5 cm). Do not apply endosulfan on European white birch and weeping birch as injury may occur.

Recommended products: Bacillus thuringiensis, carbaryl, diazinon, endosulfan, methoxychlor, oxydemeton-methyl*, permethrin, trichlorfon*

SAWFLIES AND LARVAE

see Plate 31

These insects feed in colonies, defoliating one branch then moving to the next. Many species exist, and they attack both coniferous and deciduous trees and shrubs.

The larvae of sawflies that attack conifers feed on needles and mine buds, or bore into the pith of young shoots. Fir, larch, spruce, pine and hemlock are most susceptible. The larvae look like caterpillars but have more than 5 pairs of prolegs and lack hooked spines.

Sawflies that attack broad-leaved trees are usually defoliators but can be leaf rollers, web formers, skeletonizers, stem borers or gall makers. Dogwood, birch, mountain ash, oak, locust, privet and rose are most commonly attacked. June is a critical period for sawfly larvae development, though their presence on privet is usually seen later.

European pine sawflies have dark-greenish bodies with longitudinal stripes and black heads and appear in late May and June.

Redheaded pine sawflies have yellow bodies with six rows of black spots and reddish heads. They feed on older leaves in July and August. Multiple generations can be present at one time and will attack all leaves.

Dogwood sawflies emerge as adults from late May through July to lay eggs on the underside of dogwood leaves. The larvae feed in colonies eating all but the mid-vein of the leaf. Larvae, initially covered with a white powder-like material, are yellow with three rows of large black spots along the length of their body.

Mountain-ash sawflies are yellow larvae with four

lines of black spots along the length of the body. They appear from June to early August and feed in colonies. A second generation can appear from late August to early September. Mature larvae pupate and overwinter in the soil.

Pine false webworms are the most common web-spinning sawflies, attacking red, white, Scots' and mugho pine. Adults emerge from mid-April to mid-May laying eggs on one-year-old needles. The larvae spin loose webs at the base of needles, cutting off needles to feed and producing large webbing and frass. Large bare areas remain where larvae have fed.

Rose slugs and the spiny rose sawflies attack roses. The first resemble pear slugs, slime-covered larvae, about 1 cm long, that skeletonize leaves. The second cut slits in young shoots and insert their eggs. The shoot responds by curving toward the injured side, which turns black. The larvae that emerge during June and early July are green and yellow-orange with black dots. The mature larvae fall to the ground, burrow into the soil, and overwinter as prepupa.

❖ **TREATMENT**

Cultural control: Remove individual colonies by hand and destroy whenever possible.

Chemical control: Spot spray or dust in early June when larvae are small, and repeat as necessary.

Recommended products: carbaryl, insecticidal soap, methoxychlor, oxydemeton-methyl*, permethrin.

CEDAR LEAFMINERS

The larvae feed inside the leaves of white cedar, causing the tips to turn brown. They also overwinter here. In June and July, the adults appear as tiny grey moths that take flight in clouds when cedars are disturbed. Damage is often conspicuous in the spring, but can be confused with other causes such as winter tip injury and salt injury. Leaves are hollowed out and if held up to the light, the caterpillars can be seen in their feeding tunnels. Cedars can withstand considerable injury from leafminers before significant damage occurs.

❖ **TREATMENT**

Cultural control: Clip hedges and individual plants before June, and destroy the clippings. This reduces the insect population before adult moths emerge.

Chemical control: Spray in early May before larvae pupate, and repeat in late June. If damage is severe, spray again after mid-August when young larvae begin to feed. Use a systemic insecticide that controls larvae and adults.

Recommended product: dimethoate

OR

Spray in June and July with a contact insecticide to kill adult moths before they lay eggs.

Recommended products: carbaryl, malathion.

CORN ROOTWORM BEETLES

Though corn is the principal host for this pest, the corn rootworm beetle can also cause significant damage to ornamental flowers. Many beetles fly considerable distances from cornfields to feed on ornamental flowers in gardens. They can damage the petals and stamens of chrysanthemums, roses and others.

The beetles emerge in the first week of August and are light green or yellow with black stripes, about 6 mm long. There is only one generation a year.

❖ **TREATMENT**

Cultural control: Flowers intended for show competition should be bagged to keep beetles out. Cut flowers should be shaken to dislodge the beetles before they are taken indoors.

Chemical control: Control by insecticides is not an effective alternative because beetles keep flying into the garden from corn-growing areas.

CUTWORMS

see plates 4 & 5

Cutworms are various different soft hairless caterpillars ranging in colour from light cream to bronze and black; they can be spotted or striped. The adults are variously coloured moths. They feed at night on plants with soft stems. Some kinds feed below ground; others feed above, cutting the stem or eating leaves.

❖ **TREATMENT**

Cultural control: Protect bedding plants by placing partially sunken cylinders made from tar paper or empty tin cans around each plant.

* Only available in multipurpose mixtures

** See "Resistance to benomyl", pg. 25

Chemical control: Three methods are available:

1. Apply chlorpyrifos (dust or granular) or diazinon on soil before planting and mix 5-8 cm deep.
2. Scatter carbaryl bait pellets between plants or place a few pellets at the base of each plant.
3. If damage above ground is noticed, spray or dust carbaryl, chlorpyrifos or trichlorfon on soil around stem or place carbaryl bait pellets.

EARWIGS

Earwigs are reddish-brown and about 2 cm long with a pair of forceps-like appendages at the hind end. They are active at night and hide by day in the soil or under stones or debris. They feed on many flowers.

❖ TREATMENT

Cultural control: Place damp burlap or boards on the soil as hiding places to attract the earwigs. Remove in the morning and destroy earwigs.

Chemical control: When many earwigs are found, dust or spray the soil around plants or scatter bait pellets, preferably in June or early July.

Recommended products: carbaryl (bait), chlorpyrifos, diazinon, insecticidal soap, oxydemeton-methyl*

GALL FORMING INSECTS AND MITES

Galls are abnormal growths that plant tissue develops in response to insect feeding, saliva, or egg-laying. They are rarely harmful, and should be seen as biological curiosities. Some of the most common are the reddish, felt-like patches that appear on maple leaves, the pouch-like galls on the honeylocust or the galls that form on various species of spruce. Damage might be unsightly, but rarely harms the tree.

Gall makers attack oaks wherever they are planted, forming galls of various shapes, sizes and colours on leaves, twigs, flowers and acorns. **Oak apple galls**, located on the petiole of red oak leaves, are one of the most common gall makers and cause no damage to the tree. Twig galls, however, can cause serious damage.

Maple bladder gall and **spindle gall** mites cause small bladder and spindle-shaped swellings on maple leaves. Another mite causes felt-like, reddish patches on leaves. These mites overwinter on the bark and buds of host trees, emerging to feed in spring as buds break. As they feed on newly expanding leaves, the plant responds by producing these galls, in which the mites live and multiply throughout the growing season.

Eastern spruce gall adelgids cause pineapple-shaped galls to form at the base of new shoots on Norway, white and occasionally blue spruce. Eggs are laid in early spring at the base of the buds. Upon hatching, the nymphs crawl to developing needles and begin feeding. Their continued feeding causes abnormal cell growth to form a series of bulb-like hollows forming the gall. Shoots are weakened and growth reduced. The galls are initially green, but turn brown later in the season. When the galls open in late July, winged immature females emerge and mature in early spring to lay eggs on the terminal needles in a mass of white

Maple bladder gall mite galls on silver maple

Spruce gall adelgid injury

* *Only available in multipurpose mixtures*

** See "Resistance to benomyl", pg. 25

cottony wax just as the new buds begin to break.

Cooley spruce gall adelgids attack mainly Colorado Blue and Engelmann spruce. They usually alternate between spruce and Douglas fir but may complete their life cycle on either host. The immature females overwinter near twig terminals. These mature in early spring and deposit eggs under masses of cottony wax. The nymphs move to the base of developing needles near the tip of new shoots and begin feeding, stimulating the formation of cone-like galls which develop rapidly and envelop the nymphs. The galls are blue to purplish and mature to brown by early June.

❖ **TREATMENT**

Cultural control: In most cases, no control is recommended beyond removing the galls and destroying them.

Chemical control: In severe cases, or with young trees newly established in a stressful landscape, a dormant oil can be sprayed in early spring. Do not use dormant oil on Japanese or sugar maples. With eastern spruce gall adelgid, an insecticide can be applied in October or May when the nymphs migrate to overwintering sites or new shoots.

Recommended products: dormant oil, malathion, carbaryl, endosulfan

GRASSHOPPERS

When a lush garden is located near weedy areas, abandoned fields or woodlots, grasshoppers are often a problem. This is particularly true during dry seasons, when normal food plants are less attractive and the grasshoppers migrate into the garden.

❖ **TREATMENT**

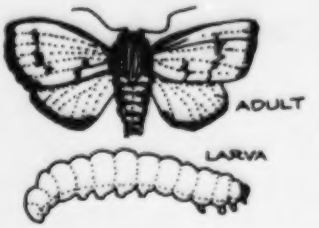
Cultural control: Trap grasshoppers in jars partially filled with molasses.

Chemical control: Young grasshoppers are much more susceptible than adults to insecticides.

Recommended product: malathion

IRIS BORERS

The larvae of these borers feed inside iris leaves, leaving visible tunnels and watersoaked areas. They tunnel downward to the rhizomes (underground stems) and destroy the inner tissue. Infestation is often accompanied by bacterial soft rot.



❖ **TREATMENT**

Cultural control: To reduce overwintering insects, gather and destroy all old iris leaves in the fall. Divide old plants soon after flowering, and remove and destroy all infested parts of rhizomes.

Chemical control: Spray in spring when leaves are about 12 cm tall.

Recommended product: dimethoate

Iris borer

LACEBUGS

These small bugs have scalloped, ornamental bodies that resemble lace. They feed on asters, chrysanthemums, ash, oak and other host plants, causing bleached flecking of the leaves. Lacebug infestations are also evident by small dark spots of excrement on the leaves.

❖ **TREATMENT**

Cultural control: None

Chemical control: Spray these insects, often hidden under the leaves, when injury is first observed.

Recommended products: malathion, carbaryl

Leaf Beetles

ELM AND WILLOW LEAF BEETLES

These small dark brown adult leaf beetles chew holes in leaves. The black larvae are even more damaging, as they skeletonize leaves. Elm leaf beetle attacks American and Chinese elm, while the willow leaf beetle attacks Lombardy poplar and willow.

❖ **TREATMENT**

Cultural control: None

Chemical control: Spray only if severe injury is noticed, usually in June.

Recommended products: carbaryl, methoxychlor

VIBURNUM LEAF BEETLES

see Plate 32

Viburnum leaf beetles, commonly found in Southern Ontario, attack American cranberry bush, arrow wood viburnum, European cranberry bush, mapleleaf viburnum, and nannyberry. Both larvae and adults devour the leaves, leaving only the major veins. The females deposit eggs in holes in the bark of twigs, and these are covered with a black cap of excrement in mid-summer. This provides protection but makes their presence detectable if the branches and twigs are carefully examined before leaves emerge in the spring. Eggs hatch in May and larvae begin feeding gregariously when leaves are about half expanded, completing their development in 8-10 weeks. The larvae pupate, fall to the ground, and emerge as adults in mid-to-late July.

❖ **TREATMENT**

Cultural control: Twigs where eggs have been laid can be pruned out in fall or early spring.

Chemical control: Spray when larvae are first detected and again seven days later.

Recommended products: carbaryl, methoxychlor.

LEAFCUTTER BEES

The work of leafcutter bees is usually little more than a curiosity or nuisance. The small black female cuts holes in the leaves of rose, azalea, Euonymus, crabapple and other plants to line her egg cells. The bee is solitary, nesting in hollow twigs.

❖ **TREATMENT**

Cultural control: None

Chemical control: None

LEAFHOPPERS

These small, greenish wedge-shaped insects jump quickly when disturbed. They feed on the underside of leaves, sucking plant sap and causing a scorched or speckled appearance to the leaf. Both adults and nymphs transmit virus diseases to host plants while feeding. Many annual and perennial plants are affected, especially delphinium, hollyhock, honeylocust, lupine, marigold, roses and zinnia.

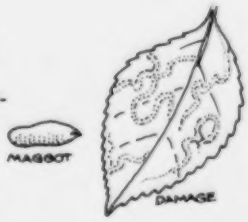
❖ **TREATMENT**

Cultural control: None

Chemical control: Spray or dust when leafhopper injury is noticed. Several applications may be necessary.

Recommended products: carbaryl, diazinon, malathion, methoxychlor, oxydemeton-methyl*

LEAFMINERS



The larvae of many flies, beetles, moths, and sawflies feed by tunnelling between outer leaf surfaces. Some create blotch-shaped or serpentine tunnels that can, if severe and repeated, reduce the aesthetic value and life of trees, shrubs, and herbaceous plants. Leafminers are common on birch, basswood, white cedar, crabapple, columbine, lilac, elm, oak, black locust, mock orange, spruce, and other ornamentals.

Leafminer populations vary from year to year, and may not be significant enough to warrant control.

❖ **TREATMENT**

Cultural control: None

Chemical control: Control the adults before or during egg-laying to prevent larvae from achieving

protection inside the plant.

Recommended products: carbaryl, malathion

OR

Control the young leafminers with systemic insecticides after they have begun tunnelling.

Recommended products: dimethoate, oxydemeton-methyl*. Dimethoate should not be applied to mock orange.

MILLIPEDES

These pests are dark brown worms about 3 cm long with 100 or more legs. They are usually found curled up like a coil spring. They feed on manure and decaying organic matter and do little or no harm to plants; hence they should not be controlled. The millipede is often mistaken for wireworm larvae, which are cylindrical, reddish-orange insects with six pairs of legs and a hard outer skin. These larvae cause severe damage to roots of plants.

❖ TREATMENT

Cultural control: None required

Chemical control: None required

MITES

Mites are small and spider-like, living mostly on the underside of leaves, where they suck plant sap. When numerous, the leaves turn a dull bronze colour, later becoming yellowish. Several different mite species attack ornamentals. Hot dry weather is favourable for two-spotted mite and European red mite. These mites attack crabapple, buddleia, mountain ash, rose, potentilla, viburnum, spirea, spruce, white cedar, and many herbaceous flowers. Spruce spider mite attacks juniper, spruce and white cedar and is considered a cool season mite.

Pearleaf blister mites cause serious injury and frequently brown and curl nearly all the leaves on infested trees and shrubs including cotoneaster, serviceberry, hawthorn, pear and mountain ash. Blister mites overwinter under bud scales and migrate to the young leaves to feed and lay eggs. Heavy feeding results in large patches of damaged tissue which become distorted or crinkled, brown or black and dry out.

❖ TREATMENT

Cultural control: Mite populations can be reduced considerably by a forceful stream of water from the garden hose, directed at the underside of leaves. Repeat every several days if mites are numerous.

Chemical control: If needed, use one of the following treatments:

1. Spray when damage indicates severe infestation. Repeat in seven days. Recommended products: chlorpyrifos, dicofol*, dinocap*, insecticidal soap, oxydemeton-methyl*.
2. Dormant oil may be applied on juniper, spruce, and white cedar in late April. Apply at the half-inch green stage (pg. 91). Dormant oil kills overwintering spider mites but not other species. Spray in the morning of a mild day so that spray dries before evening. Do not apply dormant oil on Japanese and sugar maple or on blue spruce to avoid injury.

PEAR SLUGS

Pear slugs are the larva of sawflies and are not true slugs. They are slime-covered, about 1 cm long, and are first dark green, later turning to orange. They skeletonize the leaves of hawthorn and cotoneaster, Amelanchier, rose, ornamental flowering cherry and plum.

❖ TREATMENT

Cultural control: Dusting with talc or fine, dry soil helps control this insect by causing it to dry out.

Chemical control: Spray or dust when larvae are noticed.

Recommended products: carbaryl, insecticidal soap, malathion, methoxychlor. Use any one of these insecticides at same rate as for other leaf-eating insects.

PINE SHOOT MOTHS

Damage to pine trees is done by the larvae of these moths. They overwinter at the base of the terminal whorl of buds, and feed inside the buds in

Pine shoot moth injury

May or early June. The larvae have a light brown body and black head. The adult is a small moth with rusty orange forewings marked with irregular bands of silver. It emerges in early June to begin laying eggs near the tips of the current year's shoots. Austrian, mugho, red and Scots pines are susceptible.

A flow of resin from the bud indicates the presence of larvae. Young shoots developing at this time take on a hook-shaped appearance or are killed. The death of the shoots stimulates the development of latent buds below the point of injury, producing a witches broom.

❖ **TREATMENT**

Cultural control: Whenever possible, remove infested shoots by hand in late May and early June and destroy them. Young trees less than 20 m are the most susceptible.

Chemical control: Control by spray applications is difficult. If necessary, spray thoroughly in late April and again between June 25 and July 7.

Recommended products: diazinon, dimethoate

PINE PITCH MASS BORERS

Pine pitch mass borers are the white and pink larvae of several clear-winged moths with yellow and black bodies. The larvae have a 2-3 year life cycle and affect established pines. Large pitch resin masses appear on the trunks. Stressed and wounded plants are most susceptible.

❖ **TREATMENT**

Cultural control: The larvae and pupae are found under the pitch masses in May and June. They can be picked off and killed. Maintain good tree health to reduce susceptibility.

Chemical control: None

PLANT BUGS

Weedy areas nearby provide food and shelter for plant bugs that migrate into the garden. Plant bugs cause shoots and flowers to become distorted, or leave round bleached spots on the leaves where they feed for sap. A large variety of ornamentals and herbs are affected, including ash, chrysanthemum, honey locust, marigold, zinnia, daisies, and mint.

Adult tarnished plant bugs (TPB) are brown, while the four-lined plant bugs (FLPB) are greenish-yellow with four black stripes. Both are triangular in front, 6-7 mm long and about half as wide. They are very active, readily flying when disturbed. Young TPB are light green, while young FLPB are bright red, each with dark spots and markings. TPB can be a problem throughout the season, while FLPB is prevalent in late spring and summer.

❖ **TREATMENT**

Cultural control: Thorough cleaning of the garden in the fall is important as plant bugs overwinter as nymphs or adults in garden trash and weeds.

Chemical control: Apply the insecticide when young are first noticed in the spring or when migrating adults appear.

Recommended products: carbaryl, malathion, oxydemeton-methyl*

ROSE CHAFER BEETLES AND JAPANESE BEETLES

Rose chafers are elongated, fawn-coloured beetles, 1.5 cm long. Japanese beetles are oval-shaped with metallic green bodies and copper-coloured wings.

* Only available in multipurpose mixtures

** See "Resistance to benomyl", pg. 25

Rose chafer beetles emerge from the soil in large numbers during late May while Japanese beetles emerge in early July, feeding on the blooms and leaves of trees and flowers. The beetles eat the tissue between the veins, leaving a lace-like skeleton. The larvae cause considerable damage feeding on roots. Rose and peony blooms are prime targets for the rose chafer beetle, but hollyhock, zinnia, and other flowers are also attacked. The Japanese beetle feeds on the leaves of many shade trees including linden and birch, shrubs, garden flowers, wild grape, roses and raspberries during July and August. They are best seen at dusk, when they fly to the ground to lay eggs from nearby trees.

Rose chafers (adult beetles)

For additional information, see White Grub, pg. 112.

❖ **TREATMENT**

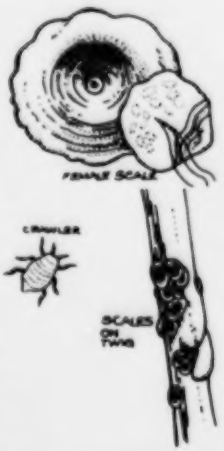
Cultural control: If only a few plants are involved, shake the chafers or beetles from the blooms into a container or sheet and destroy them.

Chemical control: Spray or dust when beetles are first noticed.

Recommended products: carbaryl, diazinon, methoxychlor. Carbaryl and diazinon are very poisonous to bees; use in late evening only, when bees are not present, or use methoxychlor.

Scale Insects

These small insects spend most of their lives under protective caps or scales attached to the bark of branches and trunks, and to pine and juniper needles. The insects suck the sap, weakening the plant. If severely infested, the bark is covered with a crusty layer of scales. One or two generations can occur per season depending on the species.



❖ **TREATMENT**

Cultural control: None

Chemical Control of Individual Scale Species during the Growing Season: The newly hatched larvae (crawlers) of the scale insects can be killed during the short time they are exposed before hiding under the scale. Correct timing of the spray for each species is essential.

The most common species are described below, along with the recommended treatments.

Cottony maple scale

Cottony maple scales have a cottony, popcorn-like appearance and occur principally on honeylocust and maple but also ash, beech and sycamore.

- Spray carbaryl, chlorpyrifos or malathion in early July and repeat 10 days later when crawlers are active.

Euonymus scales not only infects Euonymus but pachysandra and English ivy as well. The males are small white scales, while the females are larger and light brown in colour.

Second generation nymphs are often present in late August and early September and can still be controlled.

- Spray chlorpyrifos or diazinon in mid-June when the nymphs emerge and repeat 10 days later.

Fletcher scales appear as large, dark brown knobs mainly on yew but also on cedar and juniper.

- Spray carbaryl, chlorpyrifos, diazinon or dimethoate in early July or September.

Golden oak or oakpit scales are small golden discs on — or slightly sunken into — the bark of oak, especially English oak.

- Spray carbaryl, chlorpyrifos or malathion in July at 10 day intervals.

Juniper scales consist of small white, circular specks with yellow centres on twigs and needles of juniper.

- Spray carbaryl, chlorpyrifos or diazinon in late June.

Lecanium scales look like round, brown knobs on ash, cedar, crabapple, elm, honeylocust, maple and oak.

- Spray carbaryl, chlorpyrifos, diazinon or malathion in mid-July. Do not use malathion on Crimson King Norway maple.

Magnolia scales are one of the largest scales in North America. Its primary hosts are *Magnolia acuminata* (cucumber tree), *M. soulangiana* (saucer), and *M. stellata* (star). The mature female is about 12.5 mm long, oval convex, smooth, dark brown and covered with a waxy bloom. It overwinters as a nymph on one and two-year-old shoots and the crawlers emerge in late August and September. There is only one generation per year. Honeydew and sooty mould on the branches and leaves indicate presence of magnolia scale.

- Spray chlorpyrifos or malathion in late August and early September.

Oystershell scales, which resemble small oyster shells, infest ash, beech, cotoneaster, dogwood, lilac, linden, maple, willow and other smooth-barked plants.

- Spray chlorpyrifos, diazinon, insecticidal soap, or malathion in late May or early June and repeat 10 days later if necessary.

Oyster scale on lilac

Pine needle scales appear as white specks on the needles of pine and spruce, and occasionally hemlock, fir, and yew.

- Spray chlorpyrifos or malathion in late May and again in early June.

Pine tortoise scales are brown, oval convex scales about 6 mm long infesting several pine species.

- Spray chlorpyrifos or malathion in late June to control crawlers.

SLUGS AND SNAILS

Slugs and snails hide by day in dark, moist places and feed by night. Glistening slime trails are often left as evidence of their presence. The use of mulch aggravates the slug or snail problem.

❖ TREATMENT

Cultural control: See pg. 52 for beer traps. Earwigs are reported to keep slugs and snails under control as they eat the eggs and young slugs.

Chemical control: When injury to plants is noticed, apply chemical bait according to label directions. Moist bait attracts the slugs; if soil is dry, water lightly.

Use bait with care, as it is attractive and very poisonous to dogs and birds.

Recommended bait products: metaldehyde, methiocarb. Do not use methiocarb on vegetables.

SOWBUGS OR PILLBUGS

These pests have flat, oval, grey-brown bodies about 1 cm long, and seven pairs of legs. They live in damp areas under flowerpots, boards, etc., or in manure and decaying leaves. They seldom cause damage to ornamental leaves and flowers, and are most often beneficial by breaking down organic matter. For this reason, control is rarely recommended.

❖ TREATMENT

Cultural control: None

Chemical control: Sprinkle granular bait in and around the area when detected.

Recommended product: chlorpyrifos

SPITTLEBUGS

Spittlebugs are sap-sucking insects. In their immature stages, they cover themselves with a frothy saliva-like protective mass. The adults are brown and inconspicuous, and they jump easily when disturbed.

Stunting and distorting of new growth are the most common signs of damage. They are present in May and early June with usually one generation per season.

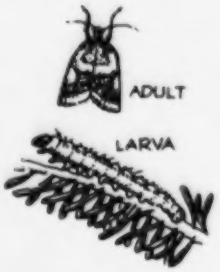
❖ **TREATMENT**

Cultural control: Nymphs can be manually picked out of the spittle mass and destroyed.

Chemical control: Apply as directed on chemical label.

Recommended products: diazinon, dimethoate

SPRUCE BUDWORMS



Spruce budworm larvae are brown with a lateral yellowish stripe and light spots on the back. These 2.5 cm caterpillars form a small nest of silk in May or early June while they feed on the needles of spruce and fir. The adults appear in July and early August as dull grey moths, the females laying eggs on needles near the periphery of the crown or terminal growth at the top of tree and the end of branches. This insect is rarely a problem in the home garden.

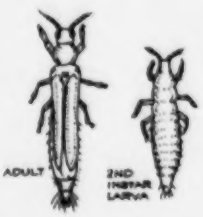
❖ **TREATMENT**

Cultural control: None

Chemical control: Treat when worms and damage are noticed. Examine trees frequently during May and June.

Recommended products: Bacillus thuringiensis, carbaryl, malathion, permethrin, dimethoate. Malathion discolours blue spruce.

THRIPS



Thrips are narrow, 3 mm long insects that hide within the plant and so are seldom seen. They suck plant sap, leaving silvery speckled or streaked marks on leaves and flowers. Both adults and larvae move very quickly when disturbed, hiding deep inside growing shoots or partially opened blooms. Damage is usually serious on gladiolus, but may also occur on iris, day lily, dahlia, rose and flowering annuals. Several species of thrips can be found in Ontario gardens but their appearance and damage are similar.

❖ **TREATMENT**

Cultural control: Remove and destroy flowers with thrips present.

Chemical control: On gladiolus, apply a preventive spray or dust when leaves are 30 cm long; treat other plants when damage is noticed. Repeat at one week intervals or as needed.

Recommended products: carbaryl, chlorpyrifos, dimethoate, malathion, methoxychlor, oxydemeton-methyl*. Always dust gladiolus corms with carbaryl before storing for winter.

WHITEFLIES

These small white insects are sap suckers, causing leaves to wither. In addition, the production of sticky honeydew by the feeding nymphs usually leads to the growth of sooty mould.

Whiteflies multiply quickly, which makes control difficult. Swarms of whiteflies are noticeable when plants are disturbed, and young nymphs may be found in large numbers on the underside of leaves. Coleus, fuchsia, hibiscus, hollyhock, impatiens, Jerusalem cherry and poinsettia are particularly susceptible.

❖ **TREATMENT**

Cultural control: Whiteflies can become a serious problem with indoor plants. For this reason, you should be particularly careful when bringing potted plants indoors for the winter. Examine each plant carefully, prune severely to remove infested leaves; then dip the plant — though not the soil or roots — in a solution of insecticidal soap. Yellow sticky traps, available at garden suppliers, can be used inside to attract and capture adults.

Chemical control: For control outdoors, spray or dust at weekly intervals but be sure to apply the insecticide to the underside of leaves as well as the upper surface. The whitefly does not overwinter outdoors.

Recommended products: chlorpyrifos, insecticidal soap, malathion, methoxychlor, permethrin

* Only available in multipurpose mixtures

** See "Resistance to benomyl", pg. 25

WHITE GRUBS

These are the larvae of June beetles, Japanese beetles, European chafers and rose chafers. The larvae are fat and white with brown heads, and are usually found in a curled "C" position. The European and rose chafer grubs are smaller than June beetle grubs. They can become a problem when sod is converted to flower beds. Young bedding plants and seedlings are most severely damaged by root feeding.

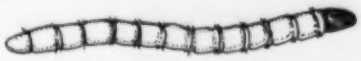
❖ **TREATMENT**

Cultural control: None

Chemical control: Treat soil around plants and water thoroughly. For information on adult damage, see the section on rose chafer (pg. 108).

Recommended product: chlorpyrifos

WIREWORMS



These are the larvae of click beetles, with a hard orange shell, six legs, and a cylindrical body about 2 cm long. As with white grubs, they are often present in new gardens when sod is converted to flower beds. Wireworms cause damage when feeding on the roots of plants.

❖ **TREATMENT**

Cultural control: For cultural control of wireworms see pg. 53.

Chemical control: None

WHITE PINE WEEVILS

A serious pest of eastern white pine, these insects will also attack Norway spruce, Scots and red pine. Open grown white pine (single trees) are particularly susceptible. Evidence of attack first shows in spring as pitch flows from the preceding year's leader. During the summer, new growth is stunted, turns brown and dies; at least two years of terminal growth is killed. As a result, lateral shoots turn upward and the tree becomes forked.

The adult weevil overwinters in litter below the tree, emerging in early spring to lay eggs in the previous season's leader. The white legless grubs feed around the base of the new shoot; larvae pupate and emerge as adults in late summer, feeding on old and new branches until winter.

❖ **TREATMENT**

Cultural control: Prune and destroy affected terminal shoots when first noticed in June and July to prevent completion of the life cycle.

Chemical control: None

ZIMMERMAN PINE MOTHS *see Plate 33*

Zimmerman pine moth larvae are grey-green with black heads, and measure 15 mm at maturity. Their feeding causes pitch resin mixed with sawdust-like frass to collect at the branch whorls on the main trunk or on shoots near the terminal branches where the larvae have entered. Individual branches eventually die completely.

❖ **TREATMENT**

Cultural Control: Remove larvae from pitch masses in June and July. Prune damaged shoots and remove heavily infested trees.

Chemical Control: None is available to the home gardener, but professional arborists can treat the trees at the appropriate time.

DISEASE CONTROL ON ORNAMENTAL PLANTS

ASTER YELLOWS

see Plate 15

Aster Yellows is caused by a mycoplasma-like organism, with symptoms similar to viral diseases. It affects China aster, calendula, coreopsis, cosmos, delphinium, daisies, marigolds, petunias, phlox, zinnia, and many other flowers and weeds. Carrots, celery and lettuce are also attacked. Plants are stunted, and the top leaves turn yellow; blooms are also stunted and may rot, taking on a greenish, leaf-like form. The disease is spread by the six-spotted leafhopper.

❖ **TREATMENT**

Cultural control: Prompt removal and destruction of affected plants is of some help.

Chemical control: Chemical control aims to check the spread of the leafhopper insect, but success is limited because there is no highly effective insecticide and because the timing of the applications are critical. See leafhopper, pg. 106.

AUTUMN SHED OF CONIFERS

This natural phenomenon is not a disease. All conifers undergo annual needle shed to varying degrees. Beginning in early autumn, needles toward the inside of the tree (closest to the trunk) turn yellow or brown and fall. Cedars and many junipers have scale-like needles covering tiny branchlets. These trees also shed the oldest branchlets in the fall.

Trees of low vigour, or under stress from factors such as drought, transplant shock, poor drainage or soil compaction may lose more than one year's quota of foliage. In such cases, identifying the problem and alleviating the stress will minimize autumn shed.

BACTERIAL SOFT ROT

This bacterial disease attacks ornamentals, particularly iris, dahlia, chrysanthemum and geranium. Soft rot of iris usually follows borer infestation. The bacteria enter through the bore holes, causing a rapid, wet rot with an offensive odour. The interior of the rhizome disintegrates into a vile, yellow mass while the exterior remains intact. Leaves wither, and the bottoms appear wet and shredded.

❖ **TREATMENT**

Cultural control: Divide infected irises, replanting only the healthy rhizomes. Do not plant too deeply. For other plants, remove as soon as observed and put in garbage. The best defense is to control the iris borer (see pg. 105).

Chemical control: None

BLACK SPOT

Black spot is common in roses. Red to black spots appear on the leaves, and the leaves, beginning at the base of the canes, turn yellow and drop. If the leaves are repeatedly wet by dew, rain or watering, the disease soon becomes serious. The loss of leaves reduces the number and quality of blooms and may so weaken a plant that it cannot survive the winter. The fungus overwinters on infected leaves and in cracks in the bark of canes.

❖ **TREATMENT**

Cultural control: If no mulch has been applied, gather fallen leaves regularly during summer and fall. If mulch is used, level the mounded soil that acted as winter protection before applying a fresh layer early in spring. Avoid watering the leaves; water the soil instead. If this cannot be done, irrigate in the morning, so the leaves will dry quickly. Some nurseries list varieties that are less susceptible to black spot than others.

Chemical control: Apply a dormant lime sulphur spray before leaf buds break to help control infections on the bark of overwintering canes. Starting when buds burst and until leaves are killed by frost, spray or dust with one of the other listed products every seven days in periods of rain, heavy dew or repeated waterings, especially when growth is rapid. During dry periods, spray or dust every 14 days. Be sure that the underside of leaves is treated.

Recommended products: lime sulphur, benomyl**, captan, chlorothalonil, copper, dichlone*, folpet, mancozeb*, sulphur, triforine**

BOTRYTIS BLIGHT
(Grey Mould, Tulip Fire)

see Plate 34

The Botrytis fungus attacks the flowers of a wide variety of ornamental plants, including begonia, tulip, peony, petunia, geranium, gladiolus and rose. On tulips, the disease begins as small beige to brown spots. During wet weather, it rapidly kills both flowers and leaves, growing down into the stalk and bulbs and often rotting them completely. This is why Botrytis is also known as tulip fire.

Botrytis typically attacks open or senescing (ageing) flowers and leaves, or enters through wounds. It quickly produces grey-brown fuzzy mould with numerous spores. Affected areas on the plant appear soft and brown, and eventually rot. Hard, black structures — sclerotia — often appear late in the season and overwinter in the soil to promote re-infection the next year when another susceptible crop is grown.

❖ TREATMENT

Cultural control: Remove all fading, senescing, and diseased plant parts promptly, particularly before predicted periods of wet weather. Improve air circulation around plants.

Chemical control: Use fungicides regularly in anticipation of wet weather.

Recommended products: benomyl**, captan

CANKER

Cankers kill patches of bark on the trunks and branches of many species of trees and shrubs. The infected sites usually appear different in colour from the surrounding bark. The canker area may be depressed, having bark that is cracked, split, or peeling away. Small, dark fruiting bodies, which are usually reddish, orange or black, not more that 0.5-1 mm dots, may be apparent, especially during moist weather when an ooze of white, amber, orange or black spores is produced. If the canker girdles the trunk, the plant dies.

Healthy plants can usually defend themselves against infection by canker-causing fungi. However, if poor soil or environmental conditions weaken the tree or shrub, the fungi can more easily take hold. Any wounding of the bark by insects, pruning, or lawnmowers creates an easy opportunity for fungi to penetrate. Cankers can also be caused on the south side of a tree by warm, sunny temperatures during the day and severe freezing at night.

Poplars, especially Lombardy poplars, are often severely affected. In fact, Lombardy poplars should not be expected to last more than 15-20 years due to canker death. The leaves on slender branches turn brown first, then the tree gradually dies from the top down. Diseased shoots and branches exhibit small, oval or elongated swellings in the ruptured bark. During damp weather, amber coloured tendrils release spores which are splashed by rain to healthy branches.

❖ TREATMENT

Cultural control: Remove and destroy badly infected trees. When partly dead trees are cut near the ground and destroyed, the stump will sprout quickly into a new tree, but it will be re-infected in a few years.

Chemical control: None

CYTOSPORA CANKER OF SPRUCE

see Plate 35

This disease damages Colorado blue and Norway spruce, but will also attack white spruce, balsam fir, and eastern hemlock. It badly disfigures but seldom kills the tree. Stresses such as drought and compacted soil predispose plants to attack.

In spring and early summer, the needles on lower branches of trees at least 10 years old turn yellow and then brown. They fall during the winter, leaving unsightly bare branches. This is an indication that cankers have completely girdled the affected branch. A clear amber resin usually oozes from the cankers, dripping onto lower branches and hardening to a white crust.

❖ TREATMENT

Cultural control: Remove the infected branches to avoid the spread of spores by wind and rain. Canker wounds on the trunk should be cleaned by cutting away diseased parts. Care must be taken to remove all brown or stained inner bark and to ensure that the edges of cuts are smooth. An oval-shaped cut with smooth edges helps the wound close more quickly. Disinfect the pruning tools after each cut by dipping into a mixture of 1 part chlorine bleach to 3 parts water. Treating wounds with tree dressing or pruning paint is not necessary.

Create the best possible growing conditions by root feeding and watering. Be sure to water espe-

* *Only available in multipurpose mixtures*

** *See "Resistance to benomyl", pg. 25*

cially well during periods of extended drought.

Chemical control: None

CROWN GALL

Crown gall is caused by a soil-borne bacterium present in most garden soils. It commonly attacks roses, Euonymus, forsythia, fruit trees, raspberries and many other plants. Conifers are not susceptible. The bacteria gain entrance through wounds, and galls or woody swellings develop on the roots, base or stem of the plant.

❖ TREATMENT

Cultural control: Avoid unnecessary wounds. Do not buy plants with galls on roots. Replace soil where a severely affected plant has grown before replanting or replant with a non-susceptible species.

Crown galls on Euonymus

Chemical control: None

DAMPING-OFF

see vegetables pg. 51

If seedlings, especially those growing in pots or flats indoors or in a cold frame, fall over and die, the seedlings have been attacked by one of the damping-off fungi. If stems turn brown or black and appear wire-like near the soil line, *Rhizoctonia* is involved. If the roots and lower stem are water soaked, soft, and tan brown in colour, *Pythium* or *Phytopthora* is involved. Most seedlings are susceptible to these soil-borne fungi.

❖ TREATMENT

Cultural Control: High soil moisture, dense seeding, and cool soil temperatures promote damping-off. To prevent this, sow seed thinly and thin overcrowded seedlings to facilitate rapid drying of soil surface. When necessary, water with warmed water, and never late in the day. Ventilate cold frames or greenhouses regularly to create drier conditions. Maintain moderate soil and air temperatures of 20-22°C.

To reduce the risk of damping-off, pasteurized soil can be used when seeding in flats or pots. Pasteurized potting soil is available at garden supply centres, or you can treat the soil yourself. Place 10 cm of moist soil in cans or metal trays in the kitchen oven at 80°C for 1 hour. Do not exceed this time and temperature. Clay pots and metal tools can be treated in the same way. Peat moss is practically free from the damping-off fungi, and should not be heat-treated, as it will smoulder. Used plastic flats and pots should be scrubbed to remove soil residues and sterilized by soaking in a solution of 1 part bleach to 9 parts water.

Chemical control: If soil has not been pasteurized, apply fungicide as a preventive treatment by drenching the soil surface before seeding or transplanting. The recommended fungicide may be applied to growing seedling plants when the disease develops, but only controls *Rhizoctonia* and not other fungi.

Recommended product: oxine benzoate.

DIPLODIA TIP BLIGHT

PINECONE WITH DIPLODIA TIPBLIGHT FRUITING SCALES

MAGNIFIED DETAIL

This fungus kills new shoots and creates resinous cankers on main stems and branches. Austrian, Scots, and red pine are most susceptible, and stresses from compacted soils or overwatering can aggravate the situation. Infection occurs in the spring, and young shoots become stunted and turn yellow before elongation of needles has occurred. Dark fruiting bodies appear at the base of the dead needles. Fruiting bodies may also be found on the scales of second-year cones, which act as carriers of infection for new shoots.

❖ TREATMENT

Cultural control: Prune the dead tips and cones, and remove dead needles that hang in the trees and harbour the fungus. Do not crowd trees; maintain adequate sunlight and air circulation.

Chemical control: There are no domestic fungicides available to control Diplodia. If control is necessary, contact a licensed tree service company.

DUTCH ELM DISEASE

When leaves, branches or entire limbs of American elm quickly wither and die, the tree is infected by Dutch Elm disease. The fungus is introduced by elm bark beetles as they feed on twigs; it spreads quickly, clogging the vascular system of the tree. One or more branches may be affected initially, but the entire tree usually dies within one or two years.

❖ TREATMENT

Cultural control: Destroy the wood of diseased elms.

Chemical control: No chemical treatment is recommended for use by the home gardener.

FIRE BLIGHT

This bacterial disease causes sudden dying of young twigs and branches, leaving a scorched appearance. Susceptible ornamental plants are cotoneaster, crabapple, hawthorn, mountain ash, firethorn, quince, ornamental pear and serviceberry. Fire blight infection occurs during flowering, when splashing rain or insects carry the bacteria to the plant.

❖ TREATMENT

Cultural control: Remove and destroy infected twigs and branches 30 cm below the scorch line. If pruning shears are used, disinfect blades after each cut in a solution of 1 part chlorine bleach to 3 parts water. Nearby trees may be the source of infection. Avoid heavy application of nitrogen fertilizer.

Chemical control: None

JUNIPER BLIGHT

Several fungi cause twigs on junipers, particularly sabina, virginana and scopulorum types, to dieback. The presence of tan-grey cankers and corresponding dieback from the canker to the tip of the twig are characteristic symptoms. At times, symptoms can easily be confused with winter injury. These fungi infect at different times of the year and so are difficult to control without a proper microscopic examination.

❖ TREATMENT

Cultural control: Prune out diseased tips to prevent re-infection. Avoid shearing plants in the fall. Provide good air circulation. Do not encourage soft, succulent growth through excessive pruning and fertilization. Avoid drought conditions.

Chemical control: Spray when spring growth starts. Repeat at ten-day intervals until growth stops.

Recommended product: copper

LEAF BLOTCH, LEAF BLIGHT, ANTHRACNOSE

see Plates 36 & 37

These common and similar diseases affect maples, London plane tree, sycamore, ash, oak, hawthorn, horse chestnut and catalpa. They are most severe when May and June are cool, wet and cloudy. Trees affected in successive years become weakened and branches gradually die.

Infection starts in early spring, when spores released from fallen leaves or infected buds and twigs attack new leaf growth. By May, the first symptoms appear: buds fail to expand and leaves develop small spots. By early summer, the small spots have become large black or dark brown blotches. The affected leaves dry out and drop prematurely.

Anthracnose of sycamore

❖ TREATMENT

Cultural control: When a few trees are fairly isolated it is helpful to gather all fallen leaves, as they carry the infection until the following spring. Burn them or put them in the garbage. This is not very effective, however, if nearby leaves are not gathered or if the fungus survives in cankers on the bark of the tree, as is the case with anthracnose of sycamore. Root-feeding and heavy watering are helpful. Maintain good air circulation.

Chemical control: None

LEAF SPOT

Several fungi and bacteria cause leaf spots on plants such as begonia, coleus, impatiens, marigold, salvia, chrysanthemum, delphinium, zinnia, iris, lily-of-the-

Leaf spot on delphinium

Leaf spot on zinnia leaves

valley and phlox. A different variety is found on catalpa and hawthorn. The disease weakens but seldom kills the plant, though its effects are enhanced by wet weather. Many of the leaf spot infections begin as small dark brown to black spots on lower leaves, and then progress up the plant. Spots increase in size, forming large black areas. The dead leaves remain on plants.

❖ **TREATMENT**

Cultural control: Remove all infected plant parts to avoid carry-over into the next growing season. Promote quick drying of leaves by adequate spacing and removal of weeds. Avoid watering in the evening.

Chemical control: Spray or dust when the first leaf spots show. If necessary, repeat twice at two-week intervals.

Recommended products: captan, copper, folpet, mancozeb*. Copper is the only fungicide that can also control bacterial leaf spot.

NEEDLE CAST OF SPRUCE

Rhizophaera needle cast is a disease of blue and white spruce causing premature death and shedding of needles. The fungus attacks young needles on the lower branches first, usually in May and June. By late summer, these needles show a yellow mottling, later turning brown or purplish-brown. Rows of tiny black dots on the needles are also noticed. The disease overwinters in infected needles on the tree or on the ground, and is spread the following spring by wind and splashing water.

❖ **TREATMENT**

Cultural control: Do not crowd trees; maintain adequate sunlight and air circulation.

Chemical control: Commercial tree maintenance personnel can apply a chemical control treatment.

NEEDLE CAST OF PINE

With needle cast of pine, the previous season's needles turn red in late winter and early spring and drop in late spring to early summer. Black fruiting bodies develop on the fallen needles. Only the current year's needles remain on the tree. This disease severely defoliates Austrian and Scots pine.

❖ **TREATMENT**

Cultural control: Do not crowd trees; maintain adequate sunlight and air circulation.

Chemical control: Commercial tree maintenance personnel can apply a chemical control treatment.

POWDERY MILDEW

see Plate 38

The first symptoms of this disease are white powdery spots on stems and leaves. If widespread, the entire leaf may become infected. On plants such as roses, the young shoots may be infected first. On many plants such as phlox, the disease starts on lower leaves. Other susceptible plants include begonia, chrysanthemum, crabapple, delphinium, lilac, Norway maple, privet, snapdragon and zinnia.

Powdery mildew can be expected after midsummer, when the days are sunny and dry and the nights are cool. This leads to extreme fluctuations in humidity levels, which promotes the development of the disease. Powdery mildew is unsightly, and will reduce the health and vigour of the plants if left untreated.

❖ **TREATMENT**

Cultural control: Plant sensitive plants in sunny locations with good air circulation. The use of overhead watering during the day has been shown to reduce the spread and development of powdery mildew. Avoid overhead watering in late after-

* Only available in multipurpose mixtures

** See "Resistance to benomyl", pg. 25

noon. Remove all plant residue in the fall to reduce the source of inoculum in the following spring.

Chemical control: Spray or dust when mildew is first noticed and repeat at 5-10 day intervals until disease is under control. To avoid injury to plants, do not apply sulphur when the temperature is above 27°C. Do not use the same chemical year after year; alternate with another from this list, especially if benomyl is used.

Recommended products: benomyl**, copper, cycloheximide, dinocap*, folpet, sulphur, triforine (on rose, phlox and zinnia only)**.

ROOT ROT

see Plate 9

Fungi such as *Pythium*, *Phytophthora*, *Rhizoctonia*, and *Fusarium* cause root and lower stem rot of herbaceous ornamentals and some woody plants. These soil-dwelling fungi are more common when contaminated soil is used to grow transplants, or when soil is wet for extended periods of time.

❖ TREATMENT

Cultural control: Remove and destroy roots and surrounding soil near infected plants. Use only sterile soil to grow transplants. Do not plant transplants or woody plants too deeply. Supply adequate water and good drainage, and avoid overcrowding. Do not plant bulbs with sunken or discoloured spots.

Chemical control: Bulbs should be dusted or treated with a slurry or fungicide, and then allowed to dry before storage or planting. Soil used to grow transplants indoors can also be treated with captan as a preventive measure. This is not usually very effective outdoors, because transplants may already be diseased.

Recommended products: captan, benomyl**

ARMILLARIA ROOT ROT

Armillaria root rot mainly attacks woody plants weakened by drought and other stresses. The roots and lower trunk show white fans of fungal growth underneath the bark, and the inner wood is discoloured. Black shoestring-like strands called rhizomorphs are found on the root surfaces, and these spread the fungus from plant to plant as they grow through soil. Clusters of honey-coloured mushrooms may appear at the base of infected plants in the fall.

❖ TREATMENT

Cultural control: Avoid planting trees too deeply or watering too much or planting in an area with poor drainage.

Chemical control: None

Rusts

Rusts are cool weather diseases that require free water for germination and infection of leaf tissue. The fungi are host specific, with hollyhock, alpine currant, geranium, pine, rose, fuchsia and snapdragon the most commonly attacked plants. Orange to reddish-brown spots or lesions with powdery masses of spores appear by midsummer on the undersurface of leaves and on stems. Control is difficult, though it is recommended that you avoid overhead watering late in the day and destroy all infected leaves or plant debris.

CEDAR-APPLE RUST, QUINCE RUST AND HAWTHORN RUST

see Plate 39

These diseases are caused by fungi with complex, two-year life cycles. They require two hosts: the red cedar juniper and a deciduous tree or bush. With cedar-apple rust, apple or crabapple serve as the second host. With quince rust, apple, crabapple, quince or serviceberry are the alternate hosts and with hawthorn rust, hawthorn serves as the alternate host.

The fungus overwinters as kidney-shaped or pitted galls on the twigs or leaves of the juniper. During warm spring rains during mid-to-late May the galls swell, producing bright orange jelly-like horns. Spores released from the horns are blown by wind to the deciduous host.

Infection on the deciduous host initially appears as small, pale yellow spots. With cedar-apple rust, orange cup-like structures with horny growths appear on the underside of the leaves by midsummer. Quince rust infects only the fruit, causing the calyx end (the remains of the flower) to become puckered and dark green in colour. In late summer, spores from these structures are blown back onto the junipers, and the cycle begins again.

Gelatinous horns protruding from cedar-apple rust gall on juniper

❖ **TREATMENT**

Cultural control: Remove galls from the junipers. Remove alternate hosts where possible.

Chemical control: Spray the deciduous hosts from flower bud until petal fall

Recommended product: ferbam

HOLLYHOCK RUST

Control can only be achieved if all common mallow and round leaf mallow weeds are removed from the area because of their susceptibility to the same rust.

ROSE RUST

Most garden roses are susceptible. Masses of yellow to bright orange powdery spores are produced on the underside of leaves and on the canes. Upper leaf surface will show reddish brown spots. Heavily infected leaves will yellow, dry and fall. Frequent rain or dew and temperatures of 18-22 °C favour development of this disease.

❖ **TREATMENT**

Cultural control: Remove infected leaves and destroy

Chemical control: In spring, spray canes with sulphur before buds break. If symptoms appear during growing season, spray with one of the listed products.

Recommended products: sulphur, ferbam

WESTERN GALL RUST ON PINE

Western gall rust commonly attacks jack, Austrian and mugho pine. It causes the formation of pear-shaped woody galls on branches and main trunk. Galls are perennial, enlarging each year, reaching 10-30 cm before dying. Branches show significant dieback and witches brooming.

❖ **TREATMENT**

Cultural control: Remove infested trees or branches.

Chemical control: None

WHITE PINE BLISTER RUST

This rust requires two hosts to complete its life cycle. The first is the white pine; the second is the red or black currant. The fungus initially invades branches and slowly spreads into the trunk, eventually killing the tree. It infects the bark, turning it orange as the stem swells and blisters. The blisters on the pine release spores that blow to currant leaves. In late summer, spores are released from the infected currant plants to infect healthy pines, and the cycle starts over.

❖ **TREATMENT**

Cultural control: Prune out infected branches from trees. Do not plant white pine and currants in close proximity.

Chemical control: There is no chemical control for rust on pine. However for control of rust on currant, the alternate host, see rust of currant, pg. 80.

SCAB

This disease affects crabapple and firethorn. Olive-green spots appear on the leaves, later turning dark brown and black. Dark, irregular spots also appear on the fruit. If the disease is severe, the skin cracks and the fruit is deformed. Leaves may drop and the following year's crop may be reduced.

The fungus that causes the scab overwinters on dead leaves on the ground. Spring rains cause the fungus spores to be released to the air and they infect young plants. If the quality of the crabapple fruit is not important, control need not be as effective as for the fruiting apple tree. However, serious damage to leaves should be prevented as the health of the tree can be jeopardized.

❖ **TREATMENT**

Cultural control: Proper pruning to improve air movement is beneficial. Resistant varieties of firethorn and crabapple are available.

Chemical control: Spray when first leaf buds break and repeat at 7-10 day intervals during May and

June, particularly during rainy periods. Do not apply mixtures containing an insecticide during bloom. Dusting is not very effective.

Recommended products: benomyl**, captan, lime sulphur (on crabapple only)

SOOTY MOULD

Black sooty mould is caused by fungi growing on the honeydew secretion of sucking insects such as aphids, mealybugs and scales. It may partially or completely cover the needles or leaves of trees and shrubs.

❖ TREATMENT

Cultural control: None

Chemical control: Control the insect problem with an appropriate insecticide. Sooty mould will disappear as the food supply becomes depleted.

TAR SPOT OF MAPLE

The characteristic symptoms of this disease are small, irregular, black tar-like spots that become evident midsummer on the upper surface of infected leaves. The surface beneath the tar spot turns brown. Leaves with multiple infections will drop prematurely. The fungus overwinters on the fallen diseased leaves, infecting new leaves the following spring.

Silver, red and Norway maple are most susceptible, but sugar and sycamore maple can also be attacked. Young trees are more likely to be weakened by leaf drop.

❖ TREATMENT

Cultural control: Although the spots detract from the appearance of the leaves, spraying with a fungicide is rarely justified. Raking up and destroying infected leaves in the fall will reduce the chance for infection the following spring.

Chemical control: None

WHITE MOULD

This disease, caused by the *Sclerotinia* fungus, affects densely growing annual plants such as marigolds, vinca and salvia during periods of wet weather or frequent watering. The symptoms are rapid browning and rotting of lower stems and leaves, with white cotton-like tufts of mycelium and round, black spore bodies — the sclerotia — embedded in the tufts. The sclerotia will remain viable in the soil for long periods of time.

❖ TREATMENT

Cultural control: Remove and dispose of diseased plants and fallen leaves as soon as you notice them. Do not compost them or work them into the soil. Avoid splashing water on the leaves. When planting, allow adequate spacing for good air circulation.

Chemical control: None

BACTERIAL WILTS AND BLIGHTS

For a full discussion of bacterial wilts and blights, see Chapter 1: Diseases Causing Plant Injury section, pg. 8.

FUSARIUM WILT

see Plate 9

This soil-borne fungus is the cause of many rots and wilts in herbaceous ornamentals. One type attacks the bulb of the lily, tulip, narcissus and crocus. The base of the bulb rots, leaving a purplish-brown tissue with pink threads. A second type attacks dianthus, while yet another affects garden chrysanthemum. These both show yellowing of leaves on one side of the stem or a complete wilting of a branch or shoot. The stem at the soil line is reddish-brown. Stunting may occur.

❖ TREATMENT

Cultural control: Dig out and remove all infected plant parts including bulbs or roots. Replace with plants that are not susceptible to the same type of Fusarium. Improve soil drainage to prevent water logging. Increase the organic matter content of the soil to avoid undue moisture stress during the summer.

Chemical control: Chemical treatment is not recommended because control is often poor. The practice may be considered for bulbs grown in pots for winter forcing.

Recommended product: benomyl**

VERTICILLIUM WILT

This soil-borne fungus attacks many ornamental trees, shrubs and flowers. It enters through the roots and gradually plugs the water conducting tissue. Susceptible plants include maple, ash, linden, catalpa, dahlia, aster, chrysanthemum, impatiens, phlox and snap-

dragon. Once the soil is infested, it will remain so indefinitely.

Verticillium wilt can have acute and chronic phases. Sudden wilting, curling and yellowing or blackening of leaves followed by premature shedding are the first symptoms. An entire tree may wilt suddenly after many years of growth, or only one limb may die while the others remain healthy. Black, dark brown or olive green streaks may be found in the outer growth rings of the wood, resulting in long cankers. If the disease is restricted to the wood of one season, compartmentalization occurs (see Wood Decay below).

❖ **TREATMENT**

Cultural control: Improve the vigour of infected trees through fertilization and watering. Remove infected branches. If Verticillium wilt kills a tree, replant with a non-susceptible tree or shrub such as walnut, oak, European mountain ash, sycamore, all conifers, boxwood, pear or mulberry.

Chemical control: None

WOOD DECAY

Many different wood decay fungi attack trees and shrubs, usually entering through wounds caused by insect or mechanical damage. Healthy plants normally close wounds with a scar-like tissue and prevent the fungi from penetrating into the wood by producing chemical barriers. This process is called compartmentalization. However, when stress factors such as drought, defoliation and soil disturbances reduce the health of the plant, these normal defence mechanisms are weakened.

Wood decay fungi grow vertically in the column of wood associated with the wound, causing discoloration, rotting, and sometimes complete disintegration of the wood. Structurally weak or hollow trees can result, presenting a hazard to nearby buildings or property. After growing extensively inside the plant, the fungi produce reproductive structures on the bark or lower trunk and roots: mushrooms, shelf-like bracket fungi, corks, or flattened pore-filled growths are common.

❖ **TREATMENT**

Cultural control: Infected trees should be examined by a competent arborist for structural soundness, and dead wood pruned out properly.

Reduce any stresses to the tree, provide adequate water, and fertilize occasionally. Avoid wounding trees as much as possible, and surgically remove loose bark and jagged edges from wounds. Research has shown that tree wound dressing or pruning paint are of no value in promoting wound closure or in preventing tree decay.

Chemical control: None

· 8 ·

LAWNS

As with all areas of your garden, the greatest protection against problems with your lawn is to ensure strong, healthy growth. A complete discussion of this topic is provided in OMAFRA factsheet #273: *Lawn Maintenance*..

Most lawns are made up of a blend of several turfgrass species. Kentucky bluegrass, tall fescues, perennial ryegrass and creeping bentgrass are the most common. All lawn grasses grown in Ontario are based on blends of these grasses, with Kentucky bluegrass as the major percentage of the blend.

LAWN MAINTENANCE

Fertilize

Provide adequate, but not excessive, nitrogen-rich fertilizer. At least half of the fertilizer should be applied in the fall. This helps generate root growth, early green-up and moderate growth rates in the spring. Split the fall fertilizing into two applications: half from mid-August to mid-September and other half from late October to early November. The spring application is best delayed until early June. If it is applied in early spring, the high nitrogen content causes lush, succulent growth, which is more susceptible to disease. Do not fertilize in hot, dry weather because grass may burn or brown patch and other summer diseases may be encouraged. For low use lawns, fertilize only once a year in early fall.

Water

Water your lawn thoroughly in the morning to encourage deep rooting. Do this only if the lawn appears dry. Excessive moisture, particularly in evening, favours disease.

Mow

Mow early in the day, as often as necessary, with a sharp mower. Dull cutting blades and evening mowing leave open wounds, allowing infection. Do not cut more than 1/4 to 1/3 off the top at any one mowing. Cutting more reduces the ability of grass to re-grow and makes it more vulner-

able to injury. Remove excessive clippings to reduce thatch build-up.

Rake

Remove excess thatch by raking or de-thatching if it is greater than 2.5 cm deep. Core aeration will also help reduce thatch build up. The aerator or coring machine, available from most rental companies, has hollow steel tines placed 10 to 15 cm apart, which remove cores of soil and thatch 6 to 8 cm long. Aerating should be done when there is adequate soil moisture. If you do not wish to aerate the lawn yourself, a lawn care company can do the work for you.

Overseed

Overseed problem areas with turf-type perennial ryegrass. Its rapid germination and establishment rates will quickly fill in the bare spots or those areas where turf has died.

Grass Selection

One way to combat the damage caused by leaf-eating insects is to plant grasses that contain endophytes. Endophytes are fungi that grow inside the grass plant and make it taste bad. The lawn insects that find endophytes repellent are hairy chinch bugs, bluegrass billbugs and sod webworms. Some cultivars of perennial ryegrass, tall fescue and fine fescue contain endophytes.

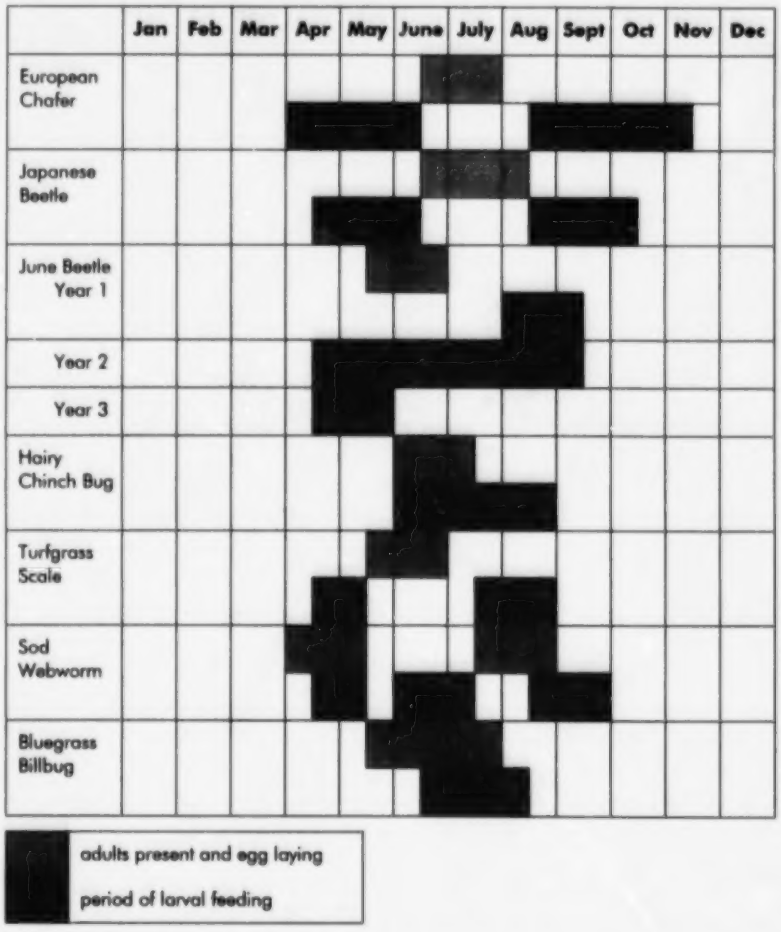
INSECT CONTROL ON LAWNS

Both insects and diseases can attack your lawn, and though their symptoms can be similar, their control measures are quite different. It is important, therefore, that you properly identify the source of your lawn problem.

Several different insects can infest lawns; the type of damage they cause results from the type of feeding they do and what part of the plant they feed on. Insects such as grubs feed on the roots. As a result the lawn can be lifted up like a carpet. Hairy chinch bugs suck the juices from grass resulting in sunken areas in the lawn with roots still firmly attached to the grass. Secondary pests such as skunks and raccoons then dig up the lawn to eat the bugs, causing worse damage than the insects themselves.

Most insects can be seen with the naked eye. If you notice damage to your lawn, check the area surrounding the damage for their presence. Use the following information to identify and control insects. The table below shows when larval feeding and the presence of adults occur for the major lawn insects.

TABLE 12: Insect Development Calendar for Lawns



INSECT CONTROL ON LAWNS

If using pesticides, follow instructions for use of pesticides on product label. Insecticides are not harmful to pets, birds or earthworms if applied correctly.

ANTHILLS

Anthills do not injure lawns, but they do make the surface uneven and can be unsightly. Specific treatments against ants are usually not necessary, as treatment against other insects will control them.

❖ **TREATMENT**

Cultural Control: None

Chemical control: Use as directed on product label.

Recommended products: carbaryl, chlorpyrifos, diazinon

HAIRY CHINCH BUGS

see Plates 40 & 41

Hairy chinch bugs suck juices from grass, causing it to wither and die. Adults overwinter in protected areas under hedges, in flower beds or near foundations and begin laying eggs in late May and early June. They are visible in early August when they emerge to feed. Adults are quite small (5 mm). Their bodies are black and white, with reddish-brown legs and wings that fold over the back of the insect. The wingless nymphs are even smaller than the adults. They are red with a white stripe across their backs when first hatched in late June, turning grey as they begin to feed and grow through July.

In July, when weather is warm and dry, an infested lawn develops dead, sunken patches that seem to spread from hedgerows, trees or flower beds. Damage is most severe in August after continued hot, dry weather.

Chinch bugs are hard to detect early in the year. If you suspect that you have a problem, push a large can (bottom removed) into the lawn and fill it with water. The chinch bugs will float to the surface after a few minutes.

❖ **TREATMENT**

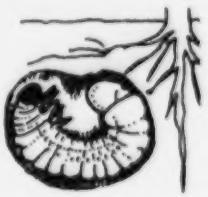
Cultural control: Avoid fertilizing excessively, as chinch bug infestations often occur more quickly on lawns with lush growth. Watering will help suppress chinch bug populations.

Chemical control: Apply insecticide in mid-July before serious damage occurs. Water thoroughly before application. Do not water for two days after application.

Recommended products: carbaryl, chlorpyrifos, diazinon

GRUBS

see Plates 8 & 42



Grubs are the larvae of a number of different beetles that feed on the roots, rhizomes and crowns of grass. Their most active time is usually from September to the end of October; they resume feeding in the spring until the end of May and beginning of June, before pupating. When irregular patches of lawn gradually turn yellow, then brown, and loose mats of dead or dying turf result, you should suspect a grub problem. Spring and early summer are often when the results of their feeding are observed, and when other animals dig up the lawn.

To examine for grubs, cut three sides of a 30 cm^2 square and pull back the grass. If there are five or more grubs per square, or if the lawn is being dug up by skunks and small mammals feeding on grubs, you have a problem, and should consider applying an insecticide.

The June beetle larva, or white grub, is C-shaped with a brown head and three pairs of long legs. It requires three years to develop into an adult, and during this time it feeds under grass. The adult beetle is dark brown or black and 2.5-3 cm long. Large numbers of beetles can often be seen at night near lights in late May and early June, during which time females are laying eggs. They feed on the leaves of trees and shrubs, causing considerable damage to oak, maple and ash trees. Damage to the lawn can occur in mid-to-late summer of the second year when the grub has been feeding since early spring.

The Japanese beetle larva is similar to the June beetle larva but is only half as big when mature. It completes

its life cycle in one year. The adult beetle, which is metallic green and bronze in colour, emerges in early July and the female lays its eggs in the lawn. It eats a variety of fruit, vegetables, trees and shrubs. Grubs hatch in mid-July, with damage occurring from early to late fall. Luckily, only a few small areas of the province have suffered infestations — Niagara Peninsula, Hamilton, Burlington, Ancaster and Dundas.

The European chafer larva also resembles the June beetle grub, but it is smaller and completes its life cycle in one year. Adults are also similar, though the European chafer is smaller and lighter in colour. It does not feed on trees and flowers to any extent. The adult chafer swarms in trees on late June and early July evenings, when females lay their eggs in the surrounding lawn. Damage occurs from early to late fall. Infestations of chafers have been reported in most of southwestern Ontario, as far north as Barrie and as far east as Peterborough.

A grub infestation can be devastating, and a complete lawn renovation is often more appropriate than the repeated use of pesticides. Renovation could include cultivating the soil after killing or removing the turf, and then seeding or sodding. If working in an area with very little soil depth (often a problem in subdivisions), additional topsoil may be required. This can be a very expensive and time-consuming task. In many cases, renovation may only require overseeding with newer grass cultivars that are more resistant to grub infestations.

There are no hard and fast rules as to when a lawn should be renovated, though for older lawns, renovation can often be very beneficial. Grubs may be a problem for several seasons, after which the grub infestation passes, or one very bad year can be enough to destroy your lawn. For more complete information, please refer to *OMAFRA Factsheet # 273: Lawn Renovation.*

❖ TREATMENT

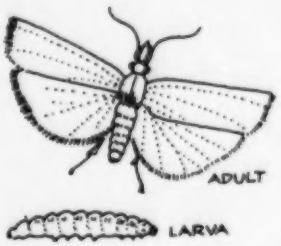
Cultural control: Once grubs have been detected, water and fertilize during warm, dry periods to keep lawn healthy and to compensate for root damage. Rake lawn after mowing to remove clippings, as excess thatch decreases stress tolerance and makes it more difficult for control products to penetrate. Mow grass a little higher to encourage root growth.

Chemical control: Apply insecticide just after the young larvae have hatched in mid to late August on watered lawns and mid-September on non-watered lawns. Apply when soil is moist and the grubs are still small and near the soil surface. Water thoroughly after application. Spring is not the appropriate time to apply a pesticide to control grubs because they are large and beginning to pupate. As a result, they are very difficult to control in the spring.

Recommended products: chlorpyrifos, diazinon

WEBWORMS

see Plate 43



Young webworms skeletonize grass blades; older worms cut them off completely. The lawn develops irregular brown patches, growing as damage increases. The first visible symptom resembles the damage done by grubs. With webworm damage, however, the dead grass easily pulls away in clumps, revealing masses of silk with bits of soil and green excrement. The silk is produced by the webworm caterpillar, a 2 cm long insect, with a dirty white body sparsely covered with hair and a dark brown head. Small, buff-coloured adult moths darting out of grass in late May and June warn that damage may begin to occur within two weeks, though damage is most common in early fall. A vigourous, healthy lawn can tolerate a considerable number of sod webworms.

❖ TREATMENT

Cultural control: Plant endophyte-enhanced cultivars of perennial ryegrass, tall fescue and fine fescue, as these varieties resist webworm feeding.

Chemical control: Spray when damage is first noticed. Do not water or mow the lawn for several days following application.

Recommended products: carbaryl, chlorpyrifos, diazinon

TURFGRASS SCALES

see Plate 44

Turfgrass scales are small, oval, 3-4 mm long, yellow-brown sap-sucking insects found in Kentucky bluegrass and red fescue lawns. Female scales lay eggs in cottony masses that hatch in late June and early July. Hatched crawlers are red and about the size of the head of a pin. In Ontario, this insect overwinters as mature nymphs. No serious damage is caused to lawns, although infested grass may green-up slowly in the spring, and crawlers leave red stains when crushed. Normal spraying for chinch may also control the crawlers.

❖ **TREATMENT**

None required.

BLUEGRASS BILLBUGS

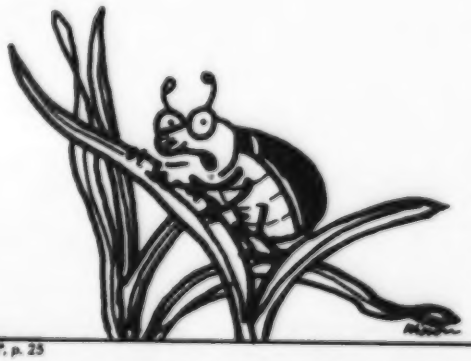
see Plate 45

Bluegrass billbug adults are black and 5 mm in length, with distinctive long curved snouts and boat-shaped posteriors. They are members of the weevil family. The larva, which is very small, legless and white with a brown head, feed on roots and crowns of grass plants, resulting in small patches of lawn turning yellow, wilting and dying. Large areas may turn yellow and die. A sawdust-like substance (frass) remains in the thatch to indicate their presence. Whereas the larvae feed on the crowns and roots of grass, adults feed on individual blades, giving them a shredded appearance. Damage occurs in July and at the beginning of August.

❖ **TREATMENT**

Cultural control: Plant endophyte-enhanced cultivars of perennial ryegrass, tall fescue and fine fescue, as these resist billbug feeding.

Chemical control: None



* Only available in multipurpose mixtures

** See "Resistance to benomyl", p. 25

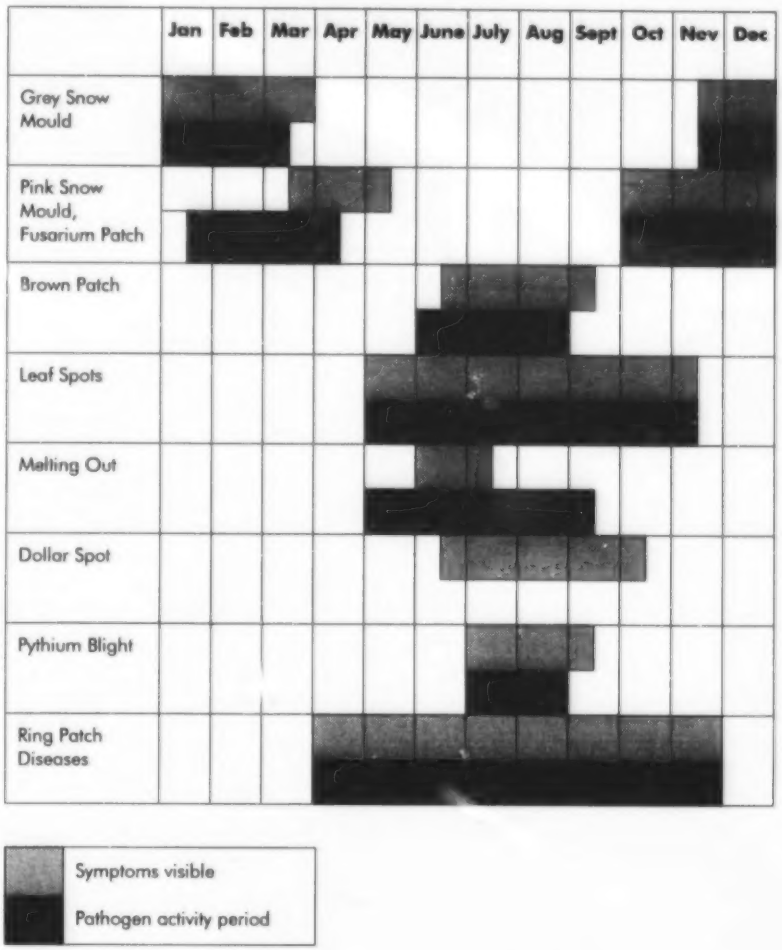
DISEASE CONTROL ON LAWNS

Both insects and diseases can attack your lawn, and though their symptoms can be similar, their control measures are quite different. It is important, therefore, that you properly identify the source of your lawn problem.

Diseases are seldom a problem in the average home lawn. They are more often found in lawns which contain a large proportion of fine turfgrasses, such as Kentucky bluegrass or creeping bentgrass, or those which are maintained in top quality appearance. In new subdivisions where lawns are sodded, disease problems usually do not occur until several years after establishment.

Use the following information to identify and control grass diseases. The table at right shows when damage occurs.

TABLE 13: Disease Development Calendar for Lawns



GREY SNOW MOULD

see Plate 46

Snow moulds occur under snow, becoming more severe when snow cover lasts longer than three months. Areas with steady consistent snow cover, therefore, are more likely to be severely attacked by snow mould than are more southerly regions.

Grey snow mould is seen as circular to overlapping patches of dead, bleached grass, 10-20 cm in diameter, that appear as the snow melts. The patches may be covered with greyish-white to pink thread-like growths (mycelium), especially on the outer edges, for several days after snow melt. Tiny, black bumps (sclerotia) can also be found on the dead leaf blades.

The fungus remains dormant in the lawn throughout the summer, surviving as sclerotia in the thatch or soil. In the fall, these germinate to release spores that are carried by wind and rain; at other times, germination occurs after snow cover. Infection occurs over the winter, and come spring, the fungus is no longer active.

* *Only available in multipurpose mixtures*

** *See "Resistance to benomyl", pg. 25*

❖ **TREATMENT**

Cultural control: Keep lawn raked to minimize thatch where fungus survives as sclerotia during inactive periods. Avoid rapid succulent growth in fall by continuing to mow until grass stops growing and apply nitrogen no later than six weeks before dormancy. A late fall fertilizer treatment can be applied after grass has stopped growing. Remove piles of snow on grass where disease can occur and break up piles in early spring to speed melting and drying.

Chemical control: Chemical control is not usually required in areas where snow cover is less than 90 days. Apply fungicide to dormant grass just before snow cover, in late October or early November. If damage is present after snow melt, vigourously rake matted areas and lightly fertilize to promote new growth.

Recommended products: chlorothalonil, benomyl

PINK SNOW MOULD AND FUSARIUM PATCH

see Plates 47 & 48

Pink snow mould is similar to grey snow mould, but there are differences. Grey snow mould is a general blight, causing the lawn to appear scalded or bleached and producing sclerotia on the leaf blades. Pink snow mould appears in distinct spots or patches of 10-20 cm in diameter and has an orange to reddish-brown appearance. These can merge to form larger irregular patches. Mycelium can be white or pink and can be seen at the outer margins of the patch up to several days after the snow is gone. As well, pink snow mould attacks all cool season grasses, while Kentucky bluegrass and red fescue are not nearly as susceptible to grey snow mould.

Fusarium patch is caused by the same pathogen as pink snow mould. During times of cool, wet weather in spring and fall, the fungus develops, resulting in small (2-5 cm), blighted patches of lawn with a strong reddish-brown colour. The disease is often more severe in areas of shade, poor air circulation, poor drainage or heavy thatch. When the disease is active, patches may have a brown ring at the outer edge and the diseased grass may be wet and slimy.

❖ **TREATMENT**

Cultural control: Rake to minimize thatch where fungus survives during the summer when inactive. Avoid rapid succulent growth in spring and fall by delaying spring fertilizer application, mowing until grass has stopped growing for the season, and applying nitrogen no later than six weeks before dormancy. Prune trees and shrubs surrounding the area to improve air circulation. Do not allow water to sit. Rake leaves in fall.

Chemical control: Fungicides have limited results. Preventive control is more important.

Recommended product: chlorothalonil

LEAF SPOT AND MELTING OUT

see Plates 49 & 50

Leaf spot first appears as small, oval, brown to purplish-brown spots on lower blades of grass between April and June. Spots expand to become oval lesions with straw-coloured centres and dark brown margins. When prolonged dull weather is followed by hot weather in early summer, the spots spread to the stems and crowns, creating massive dead or thinning patches known as melting out. Leaf spot occurs over a wide temperature range and is favoured by long periods of leaf wetness, excessive nitrogen fertilization, and low mowing height.

The fungus overwinters as spores on diseased or dead grass and becomes active in spring, producing new spores. All northern turfgrass species, especially Kentucky bluegrass, are attacked.

❖ **TREATMENT**

Cultural control: Follow proper fertilizing procedures to avoid rapid succulent growth in the spring and fall. Raise the mowing height to greater than 3.5 cm and rake to minimize thatch build-up. Water early in the morning so that the grass can dry fully. Use a resistant variety of Kentucky bluegrass such as *Baron*, *Sydsport*, or *Touchdown*.

Chemical control: Apply a fungicide in early spring when first spots appear. Repeat 10-14 days later. Do not mow or water grass after treatment with chlorothalonil until grass is thoroughly dry, preferably after 24 hours.

Recommended products: chlorothalonil, maneb

* *Only available in multipurpose mixtures*

** *See "Resistance to benomyl", p. 25*

DOLLAR SPOT *see Plate 51*

This fungus creates circular, bleached, dead spots, 5-7 cm in diameter throughout the months of June to October. When the disease is serious, these spots will overlap, causing large dead areas of lawn. Leaf blades develop hourglass-shaped lesions with bleached centres and reddish brown borders. In September, when warm days are followed by cool nights, cobweb-like fungus growth can often be seen early in the morning before the dew dries. All grasses, especially creeping bentgrass, are susceptible.

❖ TREATMENT

Cultural control: Follow proper fertilizing procedures. Dollar spot is favoured by low nitrogen levels, and can often be corrected by applying nitrogen fertilizer. Improve air circulation and reduce the level of shade to speed drying.

Chemical control: Lawns with a history of dollar spot may require fungicides, beginning when the disease appears in June or in August and September. Do not mow or water grass after treatment with chlorothalonil until grass is thoroughly dry, preferably after 24 hours.

Recommended products: benomyl**, chlorothalonil

BROWN PATCH *see Plate 52*

Roughly circular or crescent shaped brown patches, often with a central green tuft of grass, is an indication of brown patch infestation. It usually develops during the hot, humid weather of mid to late summer when temperatures are between 25-30° C and when night temperatures are higher than 20° C. On higher-cut turf this may give rise to a frog-eye appearance. On lower cut turf, diseased patches are initially purplish green and die out to a light brown. Patches may appear blighted or may just display a circular pattern of thinned-out turf of 1 m in diameter or more. All northern turfgrasses, particularly bentgrass, annual bluegrass and perennial ryegrass, are susceptible.

Highly maintained lawns, those with dense, highly fertilized stands, those that are watered frequently, and those with poorly drained thatch, are more prone to this disease. Shaded areas and areas with poor air circulation are also more susceptible. Moisture must be present on the grass for the fungus to attack healthy lawns. The fungus overwinters in the lawn.

❖ TREATMENT

Cultural control: Prune trees and shrubs to improve air movement in affected areas. Avoid applying high-nitrogen fertilizers during hot weather. Minimize thatch buildup and avoid night watering.

Chemical control: If lawn has a history of this disease, apply fungicide in anticipation of hot, humid weather, and repeat at 10-14 day intervals until weather conditions change. Do not mow or water grass after treatment with chlorothalonil until grass is thoroughly dry.

Recommended product: chlorothalonil

NECROTIC RING SPOT *see Plate 53*

This disease commonly occurs on sodded lawns three to four years after establishment. Symptoms include grass that is easily pulled out and root surfaces that are black. Outer blades of grass plant turn yellow while younger blades turn purple, then brown. Severely infected grass has few roots left because the fungus invades roots, rhizomes and crowns. It overwinters on roots and lower crowns and spreads in cool, moist fall conditions, showing symptoms from September to October. Kentucky bluegrass and fine fescues are particularly susceptible in late spring and early autumn, in full sun or shade.

❖ TREATMENT

Cultural control: Ensure that adequate phosphorus and potassium are present and apply nitrogen lightly several times during the growing season. Rake to promote vigourous growth. Overseed affected areas with resistant cultivars such as Kentucky bluegrass cultivars *Miracle, Unique, Bristol, Adelphi, Miranda, Joy, Mystic, Alpine, Washington, Princeton, NE80-88.*

Chemical control: None

SUMMER PATCH

Summer patch often attacks Kentucky bluegrass and annual bluegrass during July and August, when lawn is under stress and soil temperatures are greater than 25° C. Distinct circular patches appear, with a ring pattern up to 10 cm in diameter. Infected roots are dark brown and the grass quickly withers, turns brown and dies.

* *Only available in multipurpose mixtures*

** *See "Resistance to benomyl", pg. 25*

❖ **TREATMENT**

Cultural control: Maintain balanced fertility, avoid drought stress and excess thatch.

Chemical control: None

PYTHIUM BLIGHT *see Plate 54*

All turfgrass species, especially creeping bentgrass, annual bluegrass and perennial ryegrass are susceptible to Pythium blight. Though rarely found on mature home lawns, it can be a problem on newly seeded lawns when hot, humid conditions occur. It is more severe in areas of poor air circulation and drainage, and where the lawn has high levels of nitrogen.

Symptoms are initially similar to dollar spot, but under wet conditions the Pythium patches will be darker grey, greasy or have a water-soaked appearance, particularly in the morning. During hot, humid weather when day temperatures reach 30° C and night temperatures are above 20° C, patches grow quickly, often stretching in the direction of mowing or surface drainage.

❖ **TREATMENT**

Cultural control: Do not apply excessive nitrogen that will result in lush growth during the summer. Do not water at night. Improve drainage and air circulation and reduce shade by pruning adjacent trees and shrubs. No species is resistant.

Chemical control: None

POWDERY MILDEW

Powdery mildew is most common on Kentucky bluegrass. Greyish-white, powdery masses on leaves and stems occur in shaded areas in cooler weather, especially in fall. If severe, leaves turn yellow and die.

❖ **TREATMENT**

Cultural control: Use resistant varieties. Improve air circulation and reduce shade by pruning adjacent trees and shrubs. Keep lawn vigourous with balanced nutrition, and avoid producing too lush a lawn, as this increases susceptibility to the disease.

Chemical control: None

MUSHROOMS, FAIRY RINGS *see Plate 55*

Mushrooms may be a nuisance, but they do not damage grass. They grow on organic matter in the ground, usually decaying roots, scrap lumber or thatch.

Fairy ring, which is caused by several fungi in the soil, weakens and sometimes kills the grass in circular patterns. It is more likely to develop where there is a lot of organic matter or a high thatch build up, and is more common during long dry periods, particularly during summers which follow a wet spring. Symptoms appear as a ring of abnormal grass growth or an arc of mushrooms. Rings usually grow a few millimetres a year.

❖ **TREATMENT**

Cultural control: Remove rotting rubbish to reduce growth of fungi. Frequent heavy watering, fertilizing, heavy raking or aerating help to stimulate regrowth of grass to hide damage.

Chemical control: None

SLIME MOULDS *see Plate 56*

Slime moulds are fungi that produce masses of unsightly yellow, blue-grey or black slimy growths on grass. This eventually changes to dry, crust-like globules that produce spores. With dry weather, sunshine, or vigourous raking, the mould disappears. Although unsightly, slime moulds are not harmful and do not require control.

❖ **TREATMENT**

None required.

MOSS

Moss is most often a problem in lawns where growing conditions are not suitable for grass. Heavy shade, low fertility, or damp, poorly drained and compacted soils encourage moss growth while retarding grass growth.

❖ **TREATMENT**

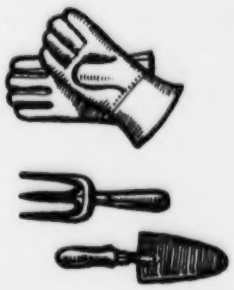
Cultural control: The causes of the poor growth conditions for grass must be removed before moss growth can be controlled. If trees or shrubs are causing the shading, you may wish to prune them back or remove several of them to allow more light through the canopy. Where shade cannot be corrected, consider using ground covers such as vinca, pachysandra or English ivy, or more shade-

tolerant grass such as fine fescues.
Drainage can be improved either by rerouting run-off water, installing tile drainage beneath the lawn or raising the lawn surface by adding soil.
Low soil fertility can also be a problem because the roots of trees and shrubs are competing for moisture and nutrients. Have soil analyzed at soil testing laboratory (see pg. A-1) before changing fertilizer program.

Chemical control: None

Appendix A:

OMAFRA - Accredited Soil Testing Laboratories in Ontario



Laboratories, accredited by the Ontario Ministry of Agriculture, Food and Rural Affairs provide a soil testing service specifically designed for the homeowner. Fertilizer recommendations based on soil test results are provided for home lawns, vegetable and flower gardens, trees and shrubs, blueberries, rhododendrons and azaleas.

Soil Sample Kits, including directions for taking soil samples and fee schedules for the various labs, are available from the Ontario Ministry of Agriculture, Food and Rural Affairs, 1 Stone Road West, Guelph, ON N1G 4Y2 and from field offices of the Ontario Ministry of Agriculture, Food and Rural Affairs.

The following laboratories are accredited to perform soil tests for pH, buffer pH, P, K, Mg and Nitrate-N on Ontario soils.

LABORATORY NAME	ADDRESS	TELEPHONE/FAX	CONTACT
A&L Canada Laboratories East Inc.	2136 Jetstream Road, London ON N5V 3P5	tel: 519-457-2575 fax: 519-457-2664	Mr. Greg Patterson Mr. Ian McLachlin
Accutest Laboratories	146 Colonnade Road, Unit 8, Nepean, ON K2B 7Y1	tel: 613-727-5691 fax: 613-727-5222/	Mrs. Lorne Wilson Mr. Peter Havelans
Agri-Food Laboratories	503 Imperial Road, Unit 1 Guelph, ON N1H 2W1	tel: 519-837-1600 1-800-265-7175 fax: 519-837-1242	Mr. Dale Cowan Ms. Nora Wilson
Analytical Services, Land Resource Science	University of Guelph, Guelph ON N1H 2W1	tel: 519-824-4120 ext.2494 fax: 519-824-5710/	Ms. Virginia Korsleka
Stratford Agri Analysis Inc. (A Daco Laboratories Ltd.)	1131 Eric St., Box 760, Stratford ON N5A 6W1	tel: 519-273-4411 1-800-323-9089 fax: 519-273-4411	Mr. Dale Peters Mr. Gary Roberts Mr. Keith Lemp

Appendix B:

Collecting and Submitting Samples to a Diagnostic Service

Samples to be tested for disease diagnosis, insect, virus or weed identification, nematodes and Verticillium can be sent to:

The Pest Diagnostic Advisory Clinic
Laboratory Services Division
University of Guelph
P.O. Box 3650,
95 Stone Rd. W.,
Zone 2
Guelph, ON, N1H 8J7

Telephone: 519-767-6256
Fax: 519-767-6240

SAMPLING PROCEDURES

A: Nematodes

SOIL

Sampling Pattern

- For fallow gardens, or gardens planted to a cover crop, take samples randomly throughout the plot.
- For row crops, take samples randomly from the feeder root zone in the rows.
- For trees, take samples from the feeder root zone (drip line) in the rows.
- For single trees, take random samples from the feeder root zone (drip line) encircling the tree.

Appendix B:

Collecting and Submitting Samples to a Diagnostic Service

Sample Depth

- Soil should be sampled to a depth of 20 – 25 cm. If the soil is bare, the top 2 cm should be removed before sampling.

Sample Size

- A soil sample should consist of 10 or more random subsamples that have been mixed together. Take 0.5 to 1 L of soil from this mixture. No one sample should represent more than 2.5 ha.

Number Of Subsamples, Based On The Total Area Sampled

500 m^2	10 subsamples
500 m^2 – 0.5 ha	25 subsamples
0.5 ha – 2.5 ha	50 subsamples

ROOTS

- Small Plants: Entire root system plus adhering soil.
- Large Plants: 10 – 20 g fresh weight from the feeder root zone.

Problem Areas

- Take samples from the margins of the problem area where the plants are still living. If possible, samples should also be taken from healthy areas in the same garden. Both soil and root samples should be taken.

Sample Handling

- Soil Samples: Place in plastic bags as soon as possible after collecting.
- Root Samples: Place in plastic bags and cover with moist soil from sample area.

Storage

- Samples should be stored between 5° - 10° C and should not be exposed to direct sunlight or extreme heat or cold (freezing). *Only living nematodes can be counted.*

B: Diseases

- A sample should include as many plant parts as possible. Even though leaf symptoms may be most evident, these symptoms are often associated with problems in the root or stem areas where symptoms may not be obvious.
- The sample should be collected from at least three plants showing similar symptoms.

Sample Storage

- Leaf and stem samples should be placed in paper bags or wrapped in newspaper, and placed in a plastic bag. They should be put into a styrofoam (or similar) cooler as soon as they are collected.
- Root samples should be tied off in a separate plastic bag to avoid drying out and to prevent contamination of the leaves and stems with soil particles.
- Samples may be stored for brief periods of time under refrigeration.

C: Insects

- Dead, hard-bodied insects and spiders should be placed in vials or boxes and cushioned with tissues or cotton.
- Dead, soft-bodied insects and caterpillars should be placed in vials containing alcohol. Do not use water as this will result in rot.
- Live insects should be placed in a container with enough plant food to support them during transit. Be sure to write *LIVE* on the outside of the container.
- Insects may also be left in the plant sample and submitted as you would a sample for disease diagnosis.

Appendix B:

Collecting and Submitting Samples to a Diagnostic Service

D: Weeds

- Weed and plant identification is easier if plants are collected when flowering or producing seed. Collect and package the samples as you would for disease identification

E: How To Collect Turf Samples

- Submit a 10 – 15 cm square piece of turf, including thatch and at least 5 cm of soil. A cup cutter size works well.
- The sample should be taken from the outside edge of a ring or patch. It should include healthy turf, unhealthy turf and the interface in between.
- If symptoms are general, collect a sample of intermediate severity. Completely dead turf is not useful for diagnosis.
- If possible, take a sample before applying fungicide.
- Do not let the sample dry out. Do not expose it to excessive heat or cold prior to submission.
- Wrap the sample in newspaper or paper towel. Pack securely in a sturdy box. Do not add water to the sample before shipping. Avoid using plastic or plastic bags.

Provide A Detailed History

Provide as much historical information as possible with the your sample. Include such information as:

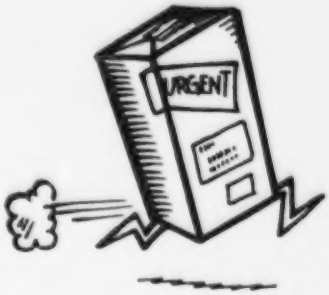
- Pattern and size of area affected
- When and where the symptoms first appeared
- What treatments have been applied
- Recent weather patterns
- Any other stresses

This information is essential for diagnosis and control recommendations.

Provide a telephone number, fax and address where you can be reached.

Delivery

- Delivery to the Pest Diagnostic Clinic should be made as soon as possible by first class mail or by courier at the beginning of the week. Avoid sending samples on Thursday or Friday because they may sit in a warehouse all weekend. It is important that samples be delivered to the Pest Diagnostic Clinic within two or three days or they deteriorate too quickly for a proper diagnosis.
- Cushion specimens and pack them in a sturdy box.



Appendix B:

Collecting and Submitting Samples to a Diagnostic Service

SAMPLE SUBMISSION FORMS

Forms can be obtained from your local OMAFRA office. Carefully fill in all of the categories on the form. In the space provided draw the most obvious symptom and the pattern of the disease in the field. It is important to include the cropping history of the area for the past three years and this year's pesticide use records.

PEST DIAGNOSTIC CLINIC FEE STRUCTURE

Basic Diagnosis	routine plant disease identification, insect identification, or weed identification	$25.00 each
* Bacterial	species identification (Biolog analysis)	$25.00 each
* Detection on virus diseases	TSWW, INSV, CYMV, ORSV, TOMV	$15.00 each
* Detection of virus diseases	TEM - transition Electron Microscope	$30.00 each
* Other procedures	Contact clinic for information	various

* The costs associated with these procedures will be added to the basic fee; no additional procedures will be performed without prior authorization.

NEMATODE and VERTICILLIUM TESTS:

Nematodes extracted from soil and/or cyst count	$25.00 each
Nematodes extracted from roots	$25.00 each
Verticillium count	$25.00 each
* Nematodes extracted from soil + nematodes extracted from roots	$35.00 each
* Nematodes extracted from soil + Verticillium count	$40.00 each
* Nematodes extracted from soil + nematodes extracted from roots + Verticillium count	$55.00 each
* Cyst count + nematodes extracted from root	$35.00 each
* Cyst count + Verticillium count	$40.00 each
* Cyst count + nematodes extracted from root + Verticillium count	$55.00 each
* Nematodes extracted from roots +Verticillium count	$45.00 each

* If nematode extraction from soil AND/OR cyst counts are required, ADD $10.00 to the above listed prices.

APPENDIX C: AVAILABLE INSECTICIDES WITH DOMESTIC LABEL
(each containing one active ingredient)

Common chemical name and concentration of active ingredient (trade names in brackets) spray, dust granular etc.	Fruit Trees	Small Fruits*	Grapes	Vegetables	Ornamentals	Lawns	NAME OR BRAND OF THE VARIOUS MANUFACTURERS AND PRODUCT NAMES
Bacillus thuringiensis				■	■		C.I.L. Organic Insect Killer
Carbaryl 15-50% Spray		■		■	■		C.I.L. Vegetable Insect Killer Sevin
		■		■	■	■	Co-op Liquid Sevin
	■	■		■	■		Co-op Sevin 50% W.P. Insecticide
	■	■	■	■	■	■	Green Cross Liquid Sevin Insecticide
	■	■		■	■	■	Green Cross 50% Spray Powder Insecticide Sevin
	■	■	■	■	■	■	Sanex Liquid Sevin Insecticide
	■	■	■	■	■	■	Wilson Liquid Sevin
Carbaryl 2-5% Dust		■		■	■		C.I.L. Vegetable Dust (Sevin)
		■	■	■			Co-op Bug Killer Insecticide Dust
		■	■	■			Green Cross King Bug Killer Insecticide Dust
				■			Sanex Cabbage Dust Insecticide
				■			Sanex 50% Sevin Dust Insecticide
	■	■	■	■	■	■	Wilson Sevin Garden Dust Insecticide
Carbaryl 5% Granular – Pellets		■		■	■		Green Cross Earwig Eliminator Bait
		■		■	■		Wilson Cutworm and Sowbug Bait Pellets
		■		■	■		Wilson Earwig Destroyer
Chlorpyrifos 5-10% Spray		■		■	■	■	C.I.L. Ant and Grub Killer E.C. (SOLGARD)
					■	■	C.I.L. Soil and Lawn Insect Killer E.C.
		■		■	■	■	Co-op Soil and Indoor Insecticide
		■		■	■	■	Green Cross Banisect
					■	■	Green Cross Liquid Spider Killer
		■		■	■	■	Wilson Emulsifiable Lawn and Soil Insect Killer
Chlorpyrifos 0.5% Granular				■	■	■	Co-op Ant and Grub Killer
				■	■	■	Co-op Cutworm Killer
Chlorpyrifos 0.5% Dust				■	■	■	C.I.L. Ant and Grub Killer Lawn and Soil Insecticide Dust Solgard
				■	■	■	C.I.L. Earwig Killer Dust
				■	■	■	C.I.L. Soil and Lawn Insect Killer Dust

* *Small fruits include raspberries, strawberries, currants and gooseberries*

Common chemical name and concentration of active ingredient (trade names in brackets) spray, dust granular etc.	Fruit Trees	Small Fruits*	Grapes	Vegetables	Ornamentals	Lawns	NAME OR BRAND OF THE VARIOUS MANUFACTURERS AND PRODUCT NAMES
Chlorpyrifos 0.5% Dust				■	■	■	Green Cross Ant and Grub Killer Insecticide Dust
				■	■	■	Green Cross Banisect Home and Garden Insecticide
				■	■		Green Cross Cutworm Dust
				■	■	■	Wilson Lawn and Soil Insect Killer Dust
Diazinon 6.5-12.5% Spray	■	■	■	■	■	■	C.I.L. Diazinon 12.5 Garden Spray Insecticide
	■	■	■	■	■	■	C.I.L. Fruit and Garden Insect Killer Diazinon
	■	■	■	■	■	■	Co-op Diazinon 12.5% E.C. Insecticide Liquid
	■	■	■	■	■	■	Green Cross Diazinon Garden and Fruit Tree Spray Liquid Insecticide
						■	Green Cross Liquid Cinch Bug and Lawn Insect Killer
	■	■	■	■	■	■	Sanex Diazinon 12.5% E.C. Insecticide
	■	■	■	■	■	■	Wilson Liquid Diazinon Insect Spray
Diazinon 5% Granular				■		■	C.I.L. Cutworm and Maggot Killer Diazinon
				■			Co-op Garden Maggot Granules
				■			Green Cross Maggot Killer Granular Insecticide
						■	Green Cross Diazinon Garden & Lawn
				■		■	Wilson's Granular Maggotox for Vegetables
Dimethoate 23-24% Spray	■	■		■	■		C.I.L. Leafminer Killer Cygon 2-E
	■	■		■	■		Co-op Cygon 2-E Liquid Systemic
	■	■		■	■		Green Cross Cygon 240 E.C. Liquid Insecticide
		■			■		Sanex Cygon 2E Insecticide
	■	■		■	■		Wilson Cygon 2E Systemic Insecticide
Dormant Oil Spray	■	■			■		C.I.L. Dormant Oil E.C.
	■						Co-op Dormant Oil Spray E.C.
	■				■		Green Cross Dormant Oil Spray
	■				■		Plant Products Dormant Oil Spray
	■				■		Sanex Dormant Oil E.C.
	■				■		Wilson Liquid Dormant Oil Spray
Endosulfan 5% Spray	■				■		Wilson's Borer Kill Liquid Insecticide
Insecticidal Soap	■	■		■	■		Green Cross Insecticidal Soap for Flowers and Vegetables

* *Small fruits include raspberries, strawberries, currants and gooseberries*

Common chemical name and concentration of active ingredient (trade names in brackets) spray, dust granular etc.	Fruit Trees	Small Fruits*	Grapes	Vegetables	Ornamentals	Lawns	NAME OR BRAND OF THE VARIOUS MANUFACTURERS AND PRODUCT NAMES
Insecticidal Soap				■	■		Safer's Aphid and Whitefly Killer
	■	■		■	■		Safer's Insecticidal Soap
	■	■		■			Safer's Natural Insecticidal for Fruits and Vegetables
					■		Safer's Natural Insecticide for Rose and Flowers
					■		Safer's Spider Mite Spray
Lime Sulphur 23-29% Spray	■	■			■		Green Cross Liquid Lime Sulfur
	■	■			■		Wilson Liquid Lime Sulfur
Malathion 12.5-50% Spray	■			■	■		C.I.L. Malathion 50
	■			■	■		C.I.L. Ornamental Insect Killer Malathion
	■			■	■		Co-op Malathion Liquid Insecticide
	■	■		■	■		Green Cross Malathion 50 E.C. Liquid Insecticide
	■	■		■	■		Sanex Malathion 50E
	■	■		■	■		Wilson 50% Malathion Liquid Insecticide
Metaldehyde 25% Spray				■	■	■	Wilson Slug and Snail Killer and Barrier Spray
Metaldehyde 2-2.75% Slug Bait Pellets				■	■		C.I.L. Slug Killer Pellets
				■	■		Co-op Slug Bait Insecticide Pellets
				■	■		Green Cross Slug Tapes
				■	■		Plant Products Slug-Em Slug Bait
				■	■		Wilson's Slug Bait Pellets
Methoxychlor 25% Spray					■		Co-op Methoxychlor 25% Liquid Insecticide E.C.
	■	■		■	■		Sanex Moxy Garden Spray Concentrate
Permethrin Spray	■		■	■	■		C.I.L. Garden Insect Killer (AMBUSH)
Pyrethrin 0.02% & Piperonyl Butoxide 0.20%				■	■		Green Cross Flower/Vegetable Bug Killer
Rotenone 0.7-1%				■			C.I.L. Garden Insect Dust (ROTENONE)
				■	■		Co-op Garden Insect Dust
		■		■			Green Cross Deritox Garden Guard Organic Insecticide
		■	■	■	■		Wilson Organic Rotenone Insect Dust
Rotenone 5% Spray		■		■	■		Green Cross Liquid Rotenone
		■	■	■	■		Wilson's Rotenone Spray Organic Insecticide W.P.

* *Small fruits include raspberries, strawberries, currants and gooseberries*

AVAILABLE FUNGICIDES WITH DOMESTIC LABEL
(each containing one active ingredient)

Common chemical name and concentration of active ingredient (trade names in brackets) spray, dust granular etc.	Fruit Trees	Small Fruits*	Grapes	Vegetables	Ornamentals	Lawns	NAME OR BRAND OF THE VARIOUS MANUFACTURERS AND PRODUCT NAMES
Benomyl 50% Spray				■	■	■	Plant Products Benomyl W.P. Systemic Fungicide
	■	■	■	■	■	■	Wilson's Benomyl Systemic Fungicide W.P.
Chlorothalonil 7.5-30% Spray						■	C.I.L. Lawn Fungicide
				■	■		C.I.L. Rose and Garden Fungicide
Lime sulphur 23-29% Spray	■	■			■		Green Cross Liquid Lime Sulfur
	■	■			■		Wilson Liquid Lime Sulfur
Maneb 80% Spray				■		■	Wilson Maneb Fungicide
Oxine benzoate 2.5%				■	■		Plant Products No-Damp
Sulphur 0.4%		■	■	■	■		Safer's Natural Garden Fungicide
Sulphur 12.0%		■	■	■	■		Safer's Natural Garden Fungicide
Sulphur 92% Spray or Dust	■	■	■	■	■		Wilson Garden Sulfur Fungicide/Miticide
Tribasic Copper Sulfate 53%	■	■	■	■	■		Wilson Wettable Powder Fungicide Spray (BORDO)
Triforine 65 g/L					■		Green Cross Funginex 6.5

AVAILABLE MULTIPURPOSE MIXTURES WITH DOMESTIC LABEL
(each containing several active ingredients)

Captan + Benomyl	■	■			■		C.I.L. Fruit and Garden Fungicide Systemic
Captan + Carbaryl					■		C.I.L. Soil and Bulb Dust Insecticide/Fungicide
Captan + Captan + Dicofol	■		■		■		Co-op Fruit and Shrub Dust or Spray Insecticide/Fungicide
Captan + Methoxychlor + Malathion				■	■		Co-op Flower and Garden Dust Insecticide/Fungicide
Carbaryl + Captan					■		Wilson's Bulb and Soil Dust Insecticide/Fungicide
Captan + Chlorothalonil				■			C.I.L. Insecticide/Fungicide for Vegetables (DEECOP)
Carbaryl + Copper				■			Co-op Potato and Tomato Dust Insecticide/Fungicide
				■			Green Cross Tomato and Potato Dust Insecticide/Fungicide
		■	■	■	■		Wilson's Tomato and Vegetable Dust
Carbaryl + Dicofol + Oxydemeton-Methyl					■		Wilson's Liquid Tree and Shrub Spray

** Small fruits include raspberries, strawberries, currants and gooseberries*

Common chemical name and concentration of active ingredient (trade names in brackets) spray, dust granular etc.	Fruit Trees	Small Fruits*	Grapes	Vegetables	Ornamentals	Lawns	NAME OR BRAND OF THE VARIOUS MANUFACTURERS AND PRODUCT NAMES
Carbaryl + Malathion + Captan	■	■		■	■		Green Cross Fruit Tree and Garden Spray or Dust
Carbaryl + Malathion + Copper + Sulphur					■		Wilson Rose and Flower Dust
Carbaryl + Malathion + Captan + Thiophanate-Methyl					■		Green Cross (GARDAL) Rose and Evergreen Dust
Carbaryl + Zineb				■			Green Cross King Products Potato Dust Insecticide/Fungicide
Copper + Carbaryl				■			C.I. L. Insecticide/Fungicide Dust for Vegetables (DEECOP)
Folpet + Carbaryl + Pirimicarb					■		C.I.L. Insecticide/Fungicide for Flowers and Vegetables
Folpet + Malathion + Carbaryl				■	■		C.I.L. Garden Dust Insecticide/Fungicide for Flowers and Vegetables
					■		C.I.L. Rose Dust Insecticide/Fungicide
					■		Wilson Rose and Flower Dust
Methoxychlor + Captan + Sulphur + Malathion	■	■		■	■		Co-op Rose Dust Insecticide/Fungicide
Methoxychlor + Malathion + Captan + Sulphur				■	■		Green Cross Multi-Purpose Flower and Vegetable Dust Insecticide/Fungicide
Methoxychlor + Malathion + Dicofol	■	■		■	■		Wilson's Liquid Garden Spray All-Purpose Insecticide
Phosalone + Ferbam	■		■				Wilson Liquid Fruit Tree Spray
	■		■				C.I.L. Insecticide/Fungicide for Fruit Trees
Trichloron + Oxydemeton-Methyl					■		C.I.L. Treen and Shrub Insect Killer (DUTOX©)

AVAILABLE RODENTICIDES WITH DOMESTIC LABEL
(containing one or more active ingredients)

brodifacoum 0.005%	See Label for Areas of Use	Wilson Wilsarin Rat and Mouse Killer Pellets
Bromadiolone 0.005%	See Label for Areas of Use	Co-op Bromone Mouse Killer
		Green Cross Rodentex Rat and Mouse Bait
		Wilson Mouse Treat Bromone
		Wilson Super Rat and Mouse Killer
Chlorophacinone 0.005%	See Label for Areas of Use	Green Cross Mouse Bait Impregnated Canary Seed Bait
		Wilson Bait Blaks Kills Rats and Mice
		Wilson Mouse Treat

* *Small fruits include raspberries, strawberries, currants and gooseberries*

Common chemical name and concentration of active ingredient (trade names in brackets) spray, dust granular etc.	Fruit Trees	Small Fruits*	Grapes	Vegetables	Ornamentals	Lawns	NAME OR BRAND OF THE VARIOUS MANUFACTURERS AND PRODUCT NAMES
Thiram 12% Liquid	See Label for Areas of Use						C.I.L. Rodent Repellent
							Plant Products SKOOT Repellent for Rabbits, Mice and Deer
							Wilson Rabbit Repell
Warfarin Concentrate 0.5%	See Label for Areas of Use						Wilson Warfarin Concentrate
Warfarin Pellets 0.025%	See Label for Areas of Use						Co-op Warfarin Rat Killer Rodenticide Pellets
							Wilson Warfarin Rat and Mouse Killer Pellets Bacon and Cheese Flavored
Warfarin Meat/Bait 0.025%	See Label for Areas of Use						Co-op Warfarin Rat Killer Rodenticide Meat
							Green Cross Warfarin Rat Killer Bait
							Wilson's Warfarin Rat and Mouse Killer Meal
Warfarin + Calciferol	See Label for Areas of Use						Green Cross Sorexa Super Mouse Bait
Warfarin + Sulfaquinoxaline	See Label for Areas of Use						C.I.L. Rat and Mouse Bait

Pressurized sprays (aerosols) containing one or more of the above active ingredients are available. They are convenient for spot treatment of individual plants. For general use, they may be uneconomical and are generally less effective than conventional sprays. When using pressurized sprays always hold container at least one-half metre from the plants to avoid damage by the spray.

Other pesticide products may be available which are not listed above. All manufacturers known to the editor were given the opportunity to supply information on their products; some did not respond.

** Small fruits include raspberries, strawberries, currants and gooseberries*

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)

100 centimetres (cm) = 1 metre (m)

1000 metres = 1 kilometre (km)

Square Measures (area)

100 m x 100 m = 10,000 m^2 = 1 hectare (ha)

100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)

1,000,000 cubic cm^3 = 1 cubic metre (m^3)

Liquid Measure

1000 millilitres (mL) = 1 litre (L)

100 L = 1 hectolitre (hL)

Dry-Liquid Equivalents

1 cm^3 = 1 mL

1 m^3 = 1000 L

Weight Measures

1000 milligrams (mg) = 1 gram (g)

1000 g = 1 kilogram (kg)

1000 kg = 1 tonne (t)

1 mg/kg = 1 part per million (ppm)

Weight - Volume Equivalents

(1.00 kg) 1000 grams = 1 litre (1.00 L)

(0.50 kg) 500 g = 500 mL (0.50 L)

(0.10 kg) 100 g = 100 mL (0.10 L)

(0.01 kg) 10 g = 10 mL (0.01 L)

(0.001 kg) 1 g = 1 mL (0.001 L)

METRIC CONVERSIONS

5 mL = 1 tsp.

15 mL = 1 tbsp.

28.5 mL = 1 fl. oz.

HOW TO USE METRIC MEASUREMENTS

Since January 1, 1981 all pesticide labels give directions in metric measurements only. The easiest way to change over to this new system is to make your measurements also in metric. This may seem difficult but it is really quite simple as long as you have the proper tools for it. You thus avoid having to calculate the conversions from imperial to metric measurements.

Measuring the surface area and length of row: For treatment of lawns and for soil insects in vegetables and flowers you have to know the surface area in square metres; for row crops, such as onion, you need the length of row in metres. Take a long stick or slat and cut it to the length of one, two or three metres (1 metre = 40 inches), depending on the size of your garden and your own preference. Now you have a handy measuring stick and you should forget about yards and feet.

Measuring the volume of water: The second tool you need is a plastic pail for preparing spray mixtures. At the levels of one, two, three, four, five, six and seven litres (1 litre = 35 fluid ounces) make marks on the inside of the pail with paint or a waterproof felt marker. To avoid other uses mark on the outside of this pail "Insecticides, fungicides only".

Measuring liquid insecticides and fungicides: You also need a tool for measuring liquid pesticides from the bottle or can. A tablespoon holds 15 mL and a teaspoon holds 5 mL. These well-known spoon measures can still be used for the metric system. Many product labels also give the rate in spoonfuls.

Measuring dry pesticides: Many manufacturers state the recommended rate for wettable powders and granular products by volume instead of by weight. Hence the tablespoon (15 mL) and the teaspoon (5 mL) can be used. Keep in mind that level spoonfuls and not heaped spoonfuls should be used. If some product labels give the rate by weight in grams, you can also use spoon measures because the level tablespoon equals about 15 grams and the level teaspoonful equals about 5 grams.

* *Small fruits include raspberries, strawberries, currants and gooseberries*

Appendix D:

Colour Plates

PLATE 1: Aphid

PLATE 2: Larval stage of Colorado Potato Beetle

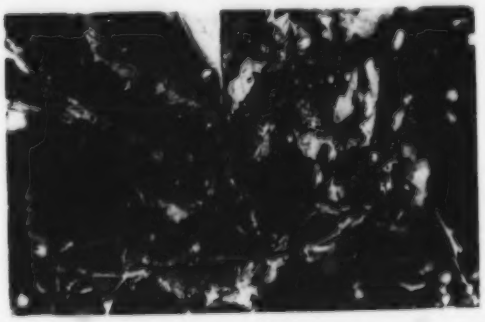


PLATE 3: Colorado Potato Beetle adult

PLATE 4: Army Cutworm

PLATE 5: Cutworm injury to young corn plants

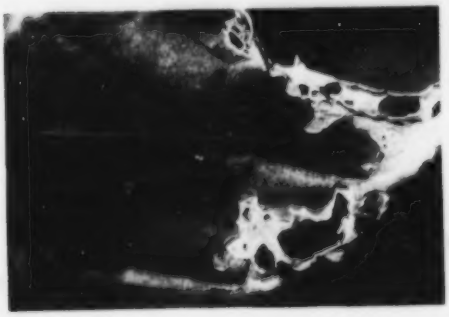


PLATE 6: Flea Beetle and injury

PLATE 7: Tarnished Plant Bug adult (left) and nymph (right)

PLATE 8: White Grub

PLATE 9: Chrysanthemum Fusarium stem rot

PLATE 10: Cabbageworm larva

PLATE 11: Cabbage Looper Caterpillar

PLATE 12: Clubroot of cabbage

PLATE 13: Diamondback Moth Larva

PLATE 14: Root Maggot and injury

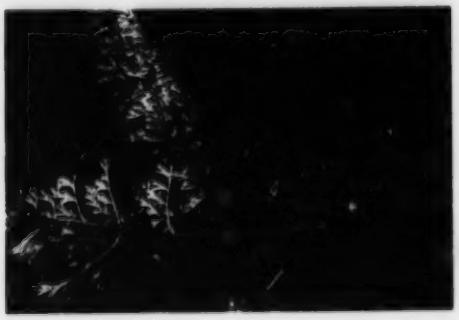


PLATE 15: Aster Yellows on carrot

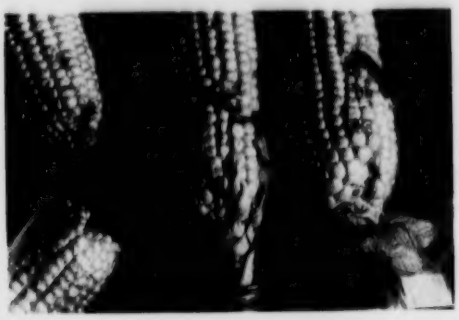


PLATE 16: European Corn Borer and damage on sweet corn

PLATE 17: European Corn Borer in corn stalk

PLATE 18: Downy Mildew on onion

PLATE 19: Botrytis Leaf Blight of onion

PLATE 20: Purple Blotch of onion

PLATE 21: Onion Thrips and injury symptoms

PLATE 21A: Common Potato Scab

PLATE 21B: Hollow Heart in potato

PLATE 22: Plum Curculio injury on apple

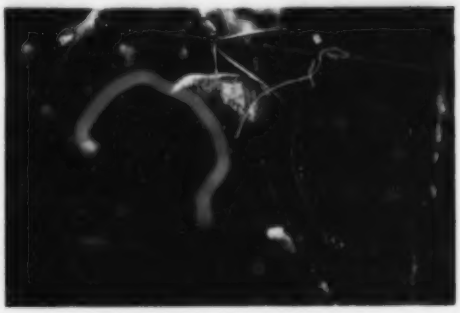


PLATE 23: Coddling Moth injury on apple

PLATE 24: Coddling Moth injury inside apple

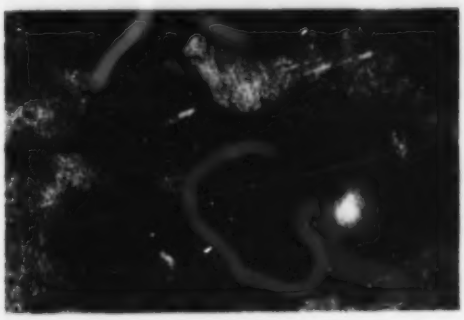


PLATE 25: Apple Scab on fruit

PLATE 26: Apple Scab symptoms on leaves

PLATE 27: Apple Maggot injury

PLATE 28: Apple Maggot and injury inside fruit

PLATE 29: Strawberry Root Weevil larva

PLATE 30: Fall Webworm tent

PLATE 34: Petunia Botrytis

PLATE 31: European Pine Sawfly Larva

PLATE 35: Cytospora Canker of Spruce

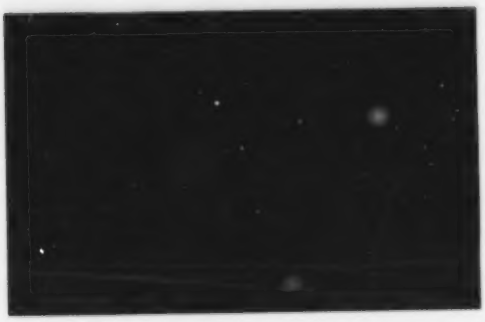


PLATE 32: Viburnum Leaf Beetle damage and larvae

PLATE 36: Anthracnose - Gloesporium on Ash

PLATE 33: Zimmerman Pine Moth injury

PLATE 37: Leaf Blotch on Horse Chestnut

PLATE 38: Powdery Mildew on rose

PLATE 41: Chinch Bug damage

PLATE 39: Hawthorn Rust

PLATE 42: White Grub Beetle

PLATE 43: Sod Webworm

PLATE 40: Chinch Bugs

PLATE 44: Scale on Kentucky Bluegrass

PLATE 45: Bluegrass Billbug

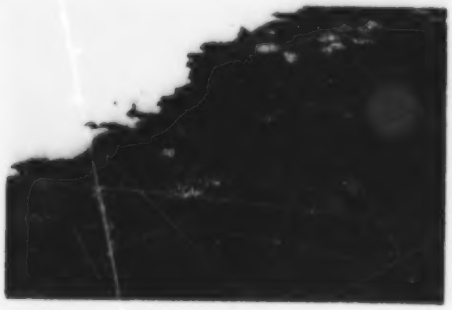


PLATE 46: Grey Snow Mould

PLATE 47: Pink Snow Mould

PLATE 48: Fusarium Patch

PLATE 49: Leaf Spot

PLATE 50: Melting Out

PLATE 51: Dollar Spot

PLATE 52: Brown Patch

PLATE 53: Necrotic Ring Spot

PLATE 54: Pythium Blight

PLATE 55: Fairy Ring

PLATE 56: Slime Mould

Emergency and First–Aid Procedures for Pesticide Poisoning

Become familiar with the chemicals you are using. Keep a list of common names in case of accidents or emergencies. This information can be found on the product labels and cross-referenced in this publication. Keep the list near the phone.

If a pesticide has come in contact with the skin or has been spilled on clothing, remove the clothing and wash the skin thoroughly with soap and warm water. Repeat the wash.

If a pesticide has come in contact with the eyes, rinse them with plenty of clean water for at least 15 minutes.

If a person suspects poisoning from exposure to a pesticide by swallowing, inhalation or contact with skin or eyes, read the label on the pesticide container and carry out the first aid treatment suggested. Never make someone vomit if they are unconcious or having convulsions.

Immediately after the first-aid treatment has been given, wrap the patient in a coat or blanket and rush him to the nearest hospital. Take the list of chemical common names with you and identify the ones being used or take the pesticide label or container.

If a person is found unconscious or lapses into unconsciousness, call an ambulance immediately.

Emergency advice on pesticide poisoning is available from the Regional Poison Information Centres at:

Toronto	1–800–268–9017
Ottawa (bilingual)	1-800–267–1373

Those needing hearing assistance should call: 1–416–597–0215 (TTY)

Emergency telephone numbers are listed at the front of each Bell telephone directory.

Fill in the following:

My local poison information centre telephone number is:

_____ - _____

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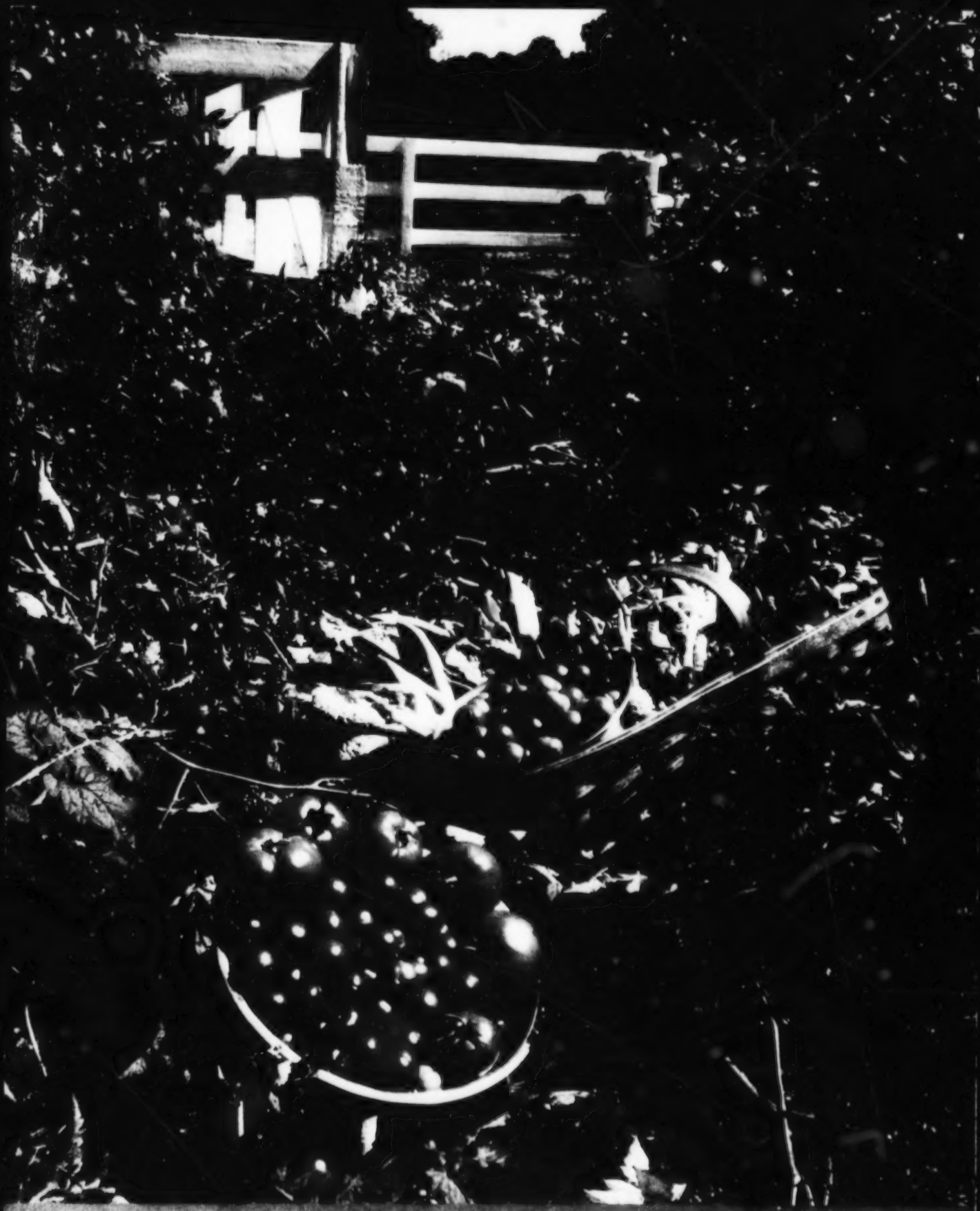

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